DING NUMBER

February, 19

Railway Engineering and Maintenance

New Conditions Demand New Methods

IN THIS ISSUE

Welding Offers Many Economies

IN THE MARCH ISSUE

(15th Annual Equipment Economies Number)

Work Equipment Problems In the Light of Today's Conditions

Prepare to Meet Next Summer's Requirements

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No. 50 of a series

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105 WEST ADAMS ST.
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Subject: BUSINESS IS GETTING BETTER

January 26, 1933.

Dear Reader:

Business is getting better. What is my authority, you ask. The railway industry itself, than which there is none better. Unlike any one business with its individual fluctuations, railway traffic is a cross section of all business, consisting as it does of the exchange of commodities between those who have produced them and others who need them and are prepared to pay for them.

Let us look, therefore, at carloadings, the index of railway business. In the five years ending with 1929, weekly loadings in September averaged 9.3 per cent higher than in July, while in 1932 they averaged 15.8 per cent larger. In October, these comparisons were 14.5 per cent and 30.3 per cent, respectively. In November, for the five-year period, they averaged 2.1 per cent above those for July, while in 1932 they were 13.3 per cent larger, and in December a decrease of 13.3 per cent compares with an increase of 2.7 per cent; and this improvement is continuing through January.

Even more striking has been the increase in net operating income. In the first eight months of 1932, this income averaged about $19,000,000 per month, whereas in September, October and November it averaged almost $50,000,000 per month.

Equally significant is the manner in which these earnings are being employed. Take railway purchases, for illustration. They reached the low point last July when they were 31.5 per cent below those for January, 1932, while every month since then has shown an increase, the spread being reduced to 16.5 per cent in October. Likewise, in employment, the minimum was reached in August. In the two following months, 36,908 persons were restored to the payrolls, while in November the total number of employees was 2.6 per cent larger than in August, as compared with an average decrease between these two months of 1.7 per cent in the years 1925-1929, inclusive.

Conditions are still bad. There is no gainsaying that fact. But they are getting better.

Yours sincerely,

Elmer T. Howson

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Editor.

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Railway Engineering and Maintenance

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FEBRUARY, 1933

Railway Engineering and Maintenance

IN YOUR TOWN

Which Transportation Agency Serves Best?

IN these days when there is no longer a monopoly of transportation, if there ever was one, and when newer and less proven agencies are competing so aggressively for the limited business that is available, it is incumbent on thoughtful citizens to compare carefully the relative contributions which these various agencies—the waterway, the airplane, the bus and truck and the railway—make to the welfare of their respective communities. Having done this, it is only the part of ordinary business prudence to patronize that agency that gives most in return—in service and in contributions to the welfare of the public in general.

Which Would You Choose

To be specific, which of these agencies provides:

1. A reliable, dependable service, day in and day out, summer and winter, rain or shine? Is it the highway operator, unregulated as to schedules, free to abandon a trip on any pretext, under no obligation to open up his routes when blocked with snow? Is it the barge line, subject to the vicissitudes of low water and other difficulties of navigation? Is it the airplane, impotent alike in fog and in storm?

Or is it the railway, whose trains operate on schedule, regardless of the volume of traffic or of weather conditions, accepting as a matter of course the obligation of restoring to service lines destroyed by floods or blocked by snow, without regard to cost, in order that those dependent on it for transportation may be served. It is a tribute to the dependability of railway service that should not go unnoticed that travelers invariably turn to the railways when storms or other obstacles put other agencies out of commission.

2. A large and dependable payroll? Is it the bus or truck lines, which have sprung up in such profusion in recent years and are disappearing almost as rapidly? Is it the waterway carriers, whose principal force consists of common labor?

Or is it the railways with their present roster of more than a million employees and with a normal force of nearly one and three quarter million persons, the support of three times that number, resident in every city and hamlet in this country? There is no parallel in transportation agencies for the railroad payroll—the backbone of thousands of communities.

3. The maximum of safety in transportation? Is it the airplane with its almost daily record of fatalities in a traffic volume totaling only a fraction of that carried by rail? Is it the commercial highway vehicle, which contributed more than its proportion to the total of more than 33,000 persons killed and a half million persons injured in accidents on the highways last year?

Or is it the railways with a record of only 4 passengers killed in train accidents in 1931, the last for which complete records are yet available? The American railways have made such a remarkable record for safety in transportation that the thought of hazard is no longer a consideration in train travel—a condition that does not prevail on the highways or in the air.

In Times of Distress

4. Relief in time of calamity? Is it to the bus and truck lines that communities turn for rescue in times of flood? Or is it to the railways?

President Hoover gave unstinted praise to the railways and to the railways alone among transportation agencies, for the stupendous aid which they gave freely and without recompense in rescuing people and stock from stricken areas in the flood of 1927 in the lower Mississippi Valley. A single railway spent more than $375,000 of its own money for rescue and relief purposes in this one flood, operating more than 400 relief trains and transporting more than 5,000 car loads of provisions, boats, etc., practically all free of charge. Other roads aided in like manner. Likewise, it was to the railways that the drought-stricken areas in the Central Eastern states turned in 1930 for reduced rates for forage and foodstuffs to enable them to tide over the disaster and it is to their credit that the railways moved more than 60,000 cars of feed in and live stock out of more than 1,000 counties, "at a great sacrifice of revenues and a material saving to the farmers," according to a resolution of appreciation adopted by the National Drought Relief Conference.

Living Wages

5. A living wage for its employees? Is it the bus or truck, which pays only what the market demands, today as low as one dollar a day in many localities, and which works its men regardless of hours, not infrequently requiring them to sleep in cramped quarters on the truck while "spelled off" by a relief operator?

Or is it the railway, whose wages are subject to re-

view by governmental agencies and whose employees rank among the best paid of all industries? It is not without significance that a recent survey of the source of employment of the purchasers of a popular priced automobile showed that more than 20 per cent were railway men while a negligible proportion were bus and truck operators?

6. Terminals that are objects of civic pride? Is it the highway carriers whose bus stations, where provided at all, are commonly eyesores, blocking the streets while loading and unloading passengers? Or is it the aviation lines, which provide few facilities of their own but look to the cities to provide the airports and supplementary facilities at public expense?

Or is it the railways, whose stations are objects of civic pride and commonly the centers of community development and progress?

Tax Payers or Spenders

7. Taxes for the support of government? Is it the aviation lines with their limited investment in planes and hangars? No, for they are, on the contrary, tax spenders, calling on the cities for the expenditure of public funds for airports and on the federal government for the lighting of their routes for night flying, for subsidies for the carriage of mail, etc., totaling more than $19,000,000 annually.

Is it the waterways? No, for the government expends millions of dollars annually to provide and maintain channels free of cost to the user, the local municipalities commonly provide terminal facilities at nominal rental, and the government, even after absorbing many costs which a railway must bear, defrays the deficit from its barge line operations on the Mississippi and Warrier rivers.

Or is it the highway carrier who operates on roads built at public expense, who pays in license and gasoline taxes as rental for the use of these highways only a fraction of the cost incurred by the public in his behalf and who contributes almost nothing for the support of government itself?

Or is it the railways, which receive from the government no subsidies or financial assistance, which provide their own terminals, which construct and maintain their own rights of way and which, in addition, pay more than a million dollars a day in taxes for the support of government at large?

Which Buys the Most

8. A market for many of the industries of the country? Do the barge lines, through their purchases, support vast factories making the materials they use? Or do the employees of those companies making commercial highway vehicles reach into the hundreds of thousands?

Or is the railways, whose purchases normally exceed $2,300,000,000 and whose operations normally consume nearly a fifth of all the steel produced in the country, a still larger proportion of the lumber cut and hundreds of other materials in like proportions? The thousands of plants throughout this vast country producing the materials used by the railways give employment, in normal times, to more than one and one-half million persons. Their purchases support directly more than five million persons throughout the country.

9. A principal source of investment for insurance companies, savings banks and individual investors?

Is it the bus or truck operator, with his high business mortality and his lack of proven earning capacity? Is it the aviation line with its record of unprofitable operations, receiverships and reorganizations?

Or is the railways, with their stability of investment? More than five billion dollars of railroad securities are today held by our strongest insurance companies and savings banks. Billions more are held in endowment funds of colleges and universities, hospitals and other philanthropic institutions.

10. Assistance in civic activities? Do you find the bus agent there? Or the representative of the air line? Or is it the local railway agent who owns his home in the community and who takes an active interest in the betterment of community life, co-operating in such work wherever opportunity offers?

Affects Nearly Everyone

11. An income for hundreds of thousands of widows and other small investors? Is it the waterway? Or the bus or truck line? Or the aviation line?

No, it is the railroads whose owners comprise citizens in every walk in life, who look to them for a return on their life savings.

In short, the railways are citizens of the communities they serve to a degree that is approached by no competing transportation agency. As such, they are entitled to protection against the competition of less desirable citizens, commensurate with their value to the community. Possibly this value is best measured by endeavoring to visualize a community—your community—with the railway removed.

This is a comparison which railway employees may well emphasize in their respective communites.

MANGANESE TRACKWORK

Welding Provides Incentive for Better Construction

AFTER many conflicting reports regarding the success of attempts to repair manganese steel trackwork by welding, this work has finally been established on a thoroughly practical basis within the last three or four years through the development of the electric arc for such work. That early difficulties should have been encountered is not surprising for the successful welding of manganese steel involves a technic radically different from that employed in the welding of carbon steels, which had to be thoroughly understood and perfected before reliance could be placed on such work.

Even today not all welding of manganese frogs and crossings is successful, but in the majority of cases of failure this is due to an attempt to accomplish the impossible. Arc welding cannot restore a seriously damaged piece of trackwork to a condition approaching that of a new frog or crossing. This is well understood by the contractors regularly engaged in this work, and under the 90-day guarantee clause usually embodied in the terms of the contract, they decline to undertake work which is not reasonably certain to be successful. Furthermore, both the contractors and those railway mainte-

nance officers who have given such repair work close study are convinced that this process has its greatest field for usefulness when employed as a means of maintenance rather than as an effort at reclamation. In other words, a valuable piece of trackwork will be kept in service longer if the welding is done to make good the effect of wear or to repair incipient breaks than if it receives no attention until serious damage has been done.

Because of the special knowledge and skill required for successful work, it is better not to attempt it at all than to undertake the repair of the manganese steel work with inadequately trained men. For this reason, it is better for a railway to have the work done by an experienced contractor unless it is prepared to organize and train a force especially for this work and see that it is properly supervised. Special care should be taken to insure that efforts to obtain low costs are not permitted to result in the use of cheap rods or hurried work.

The successful repair of manganese trackwork is resulting to the economic advantage of the railroads; it is also reacting to the advantage of the manufacturer of manganese trackwork, for, as it is demonstrated that his product is capable of a much longer service life than was previously obtained from it, it becomes more valuable to the buyer. The net result should be a willingness on the part of the railways to pay for the best quality of manganese trackwork and an ability to make use of it in locations where they have been unable to justify the investment in the past.

WELDING

As Applied to Track and Structures

NO SCIENTIFIC development of the past two decades has been of greater aid to the railway maintenance officer during his present trials than the autogenous welding processes. Having been developed to a high degree of usefulness for purposes of conservation during periods of prosperity, they have proved virtually indispensable during a time when it has been necessary to maintain in service many elements of the property that would normally have been renewed. It is for this reason that it has seemed especially fitting that in this issue of *Railway Engineering and Maintenance* special attention should be given to an account of the progress that has been made in this field and to detailed descriptions of the manner in which these processes are being employed in their various applications.

This is not the first time that welding has been discussed in these pages, because it has been the policy of *Railway Engineering and Maintenance* to keep its readers advised of current developments as they take place. But progress has been so rapid and so far-reaching that the articles appearing on following pages, while designed to provide a comprehensive account of the complete scope of welding as applied to railway track and structures, are intended as well to present the latest developments.

Two entirely distinct processes are involved—one employing the oxy-acetylene torch and the other the electric arc. Each has its own field of usefulness; both are being employed in the building up of rail ends, while in the structural steel work, where arc-welding is more largely used, the oxy-acetylene cutting torch has become a valuable auxiliary. Obviously, it is not our province to express preference for one process or the other. The decision as to which process is to be applied in each case must rest with the reader.

WOOD PRESERVATION

Is Paying Big Returns in These Trying Days

ESTIMATES based on reliable information indicate that the tie renewals during the last three years were inadequate in the amount of 10 million ties in 1930, 20 million in 1931 and 30 million in 1932 so that at present the accumulated deferred tie renewals approximate 60 million. This means that, in the near future, the railways will be compelled to make up almost a full year's normal renewals if they are to restore their tracks to a normal tie condition.

To one who is not familiar with track maintenance, this would appear to be an alarming situation, but, taking the railroads as a whole, it is not. The general practice of treating crossties, plus the application of large tie plates, has reduced the normal tie renewals required to scarcely more than half the number required only 20 years ago. As a result, the average number of ties that any of the better-maintained roads would have to insert this year to take care of all replacements would be but slightly greater than the renewals they had to make every year not more than 20 years ago.

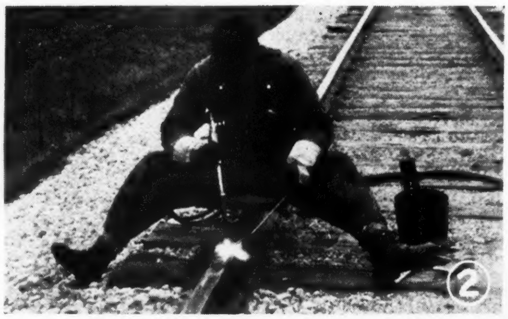
This fact is, of course, no justification for a complacent attitude. No element of the track structure is more important from the standpoint of safety than the crosstie, and tie condition must be watched carefully, especially to make sure that bad ties do not come in bunches. It is well also to keep in mind the reason why the tie condition is no worse than it is—the excellent practice in selection, treatment and care that has prevailed of late years. If there is any letting down now in the quality of ties inserted, it will only delay that much longer the time when the normal renewal requirements are reduced to the low figures that prevailed in 1929.

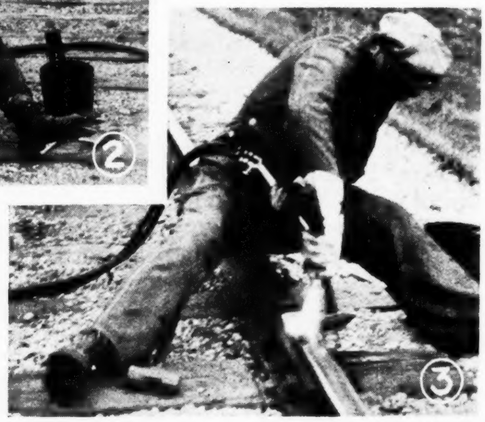
While figures are not available from which to draw a parallel with respect to wooden bridges, it is self-evident that the same observations apply. It is only those roads with large mileages of untreated bridges that are confronted with large expenditures for renewals in these days when money is so hard to get.

On the Canadian National in the Province of Quebec

Extending Life of

Illinois Central's Experience in rebuilding 845,000 joints indicates economy of practice now standard on this railroad





IN THE more than 12 years during which the Illinois Central has been building up rail ends by gas welding, it has reconditioned 845,000 joints. So satisfactory have been the results that this road is continuing the practice on an increasingly large scale, 158,000 joints having been built up in this manner in each of the last two years, while the tentative program for the coming season calls for a still larger operation.

Experience has demonstrated that through this practice the service life of the rail is being extended from three to eight years, and that even for the lighter rail sections an extension of three years in service more than offsets the cost of the work. While costs are watched closely, this feature of the work is not stressed unduly, since excellence of work is preferred to unusually low costs, experience having shown that the two are not compatible.

All work is done by division gangs which are organized and supervised by the division officers, with the track supervisor in direct charge. Service representatives of the Oxweld Railroad Service Corporation instruct the welders in the best methods of doing the work and keep them and the division officers advised of the latest developments in methods and equipment.

Beginning in 1921, the Illinois Central reconditioned four miles of 90-lb. rail between Elroy, Ill., and Freeport. Owing to conditions growing out of the war, this rail had been left in track beyond what was then considered its normal service life and the joints were badly battered. Because of the many demands on the tonnage of new rail available that year, it was decided to build up the battered ends of this stretch of rail as an experiment. The results were so satisfactory that in the following year 4,400 joints, or about 14 miles of rail, were similarly treated. This was increased to 29,000 joints in each of the two succeeding years, since which time the practice has become standard on this road.

Two Types of Gangs Are Employed

Two types of gangs are employed to recondition the joints. A typical gang for the larger operation consists of a foreman, an experienced trackman who is also trained in welding, 4 torchmen, 2 helpers and 2 laborers. In addition to the torches and accessory welding equipment, these gangs are supplied with a surface grinder from which a cross-grinding wheel can also be operated. At present, five of these grinders are in service, 3 made by the Nordberg Manufacturing Company and 2 by the Northwestern Motor Company. The gangs are also provided with either monorail cars or pony cars for moving the gas tanks. This equipment is moved from division to division during the progress of the season's work, in accordance with a pre-arranged schedule.

In advance of the welding, the foreman, who has previously gone over the track with the supervisor, makes a final inspection of the joints, using a 24-in. straight edge and taper and feeler gages to determine the length and depth of the batter. He marks the limits of the weld as a guide to the welder and cuts away any loose or defective metal, this being done usually at chipped joints. After the welder leaves, the joints are inspected to determine whether they are well filled as to length and depth. He then makes a final inspection after the surface and cross grinding are completed, when defects that were not readily visible on the previous inspection are more easily detected.

To insure that responsibility for poor workmanship can be traced correctly, each torchman is furnished with a die with which he places his mark on every joint he builds up. In this way the occasional failures which occur, perhaps days or weeks later, can be traced to the welder who did the work.

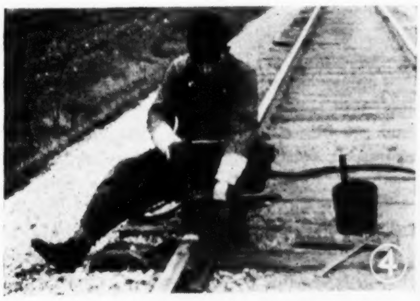
When a gang starts in the morning, the torchmen are spaced along the track so that each one will have 10 joints as his immediate assignment. When he has completed these, he moves ahead to another similar allotment, and this system is repeated as often as necessary throughout the day. A spacing of 10 joints keeps the gang reasonably compact, yet it minimizes

Life of Rail by Gas Welding

the number of moves and the interference and lost time which result from moving too frequently. This spacing also lends itself to a better distribution of the gas tanks.

As he starts to work on a joint, the welder measures with a straight edge the depth of the depression and checks the length, as marked by the foreman. He then heats the ends and corners of the rail head within the limits of the weld to a forging temperature and forges them with a 4-lb. hammer, if any reshaping is necessary. Following this, the rail is again heated and the new metal is applied. During this part of the operation the added metal is forged repeatedly until the depression has been completely filled.

After the finished weld has been inspected by the foreman, it is ground by the helpers, one of whom operates the surface grinder and the other follows with the cross grinder. These men also assist the welders as required. The two laborers handle and set up the gas tanks in preparation for the welding, replace them when empty, and move and set them up when the welder



moves ahead, sufficient hose being provided so that 10 joints can be completed from one location of the gas tanks. These men also tighten bolts or change angle bars as may be necessary, do such flagging as is required and oil the joints after the welding and grinding are completed.

Smaller gangs are used where welding is required over short stretches of track or where only occasional joints require attention. As a matter of fact, practically all of their work is spot welding. These gangs consist of 2 welders and 1 helper, the older or more experienced welder being in charge. They are provided with the same welding tools and incidental equipment as the larger groups, but do not have the grinders. For this reason, while they use the same methods in welding, they are compelled to use flatters to finish the welds.

Late in the season, preliminary to the preparation of the maintenance budget for the ensuing year, the division engineer and the supervisors make a preliminary inspection of the division to determine what track shall be recommended for welding during the following season. They do not at this time measure the batter on all of the joints, but take a sufficient number of measurements to determine the general trend of the batter, relying on visual inspection for the other conditions surrounding the rail. At this time, if the inspection indicates that from 50 to 60 per cent of the joints are battered to the extent of 3/64 in., the track is included in the budget recommendations. In this connection and for the purpose of preparing the budget, chipped ends are considered as being in the same category as battered ends.

In the spring, after the budget has been approved, a more careful inspection is made and a larger number of joints are measured to determine definitely the extent of the work that will be necessary. At this time a decision is reached as to the final plans for carrying out the work and when it will be undertaken, or rather the order of preference which will be given to each stretch of track on the division. The condition of the angle bars is also ascertained and a decision reached as to the number that should be replaced.

All Joints Not Rebuilt

In connection with these inspections and the later progress of the work, it should be stated that while any track that is included in the welding program is worked over progressively from end to end, this does not imply that it is necessary to rebuild every joint. Experience has shown that, although 50 to 60 per cent of the joints may be battered a sufficient amount to require reconditioning, many others will have no appreciable batter or not enough to justify the cost of welding.

It should also be stated, however, that where the batter is approaching the limit that has been set as the measure of necessity for welding, such joints are cared

1. Separating and shaping the rail ends. 2. Applying the new metal. 3. Forging the rail head and added metal. 4. Shaping the joint gap at the end of the welding. 5. Chamfering the finished joint

for without question. In other words, while the intention is to keep the process on a definitely defined economic basis, it is recognized that a certain amount of latitude is necessary in its application. For these reasons, in general, the question of what joints shall or shall not receive treatment is left to the judgment of the local officers, who are as much interested in avoiding unnecessary costs as their superiors. Furthermore, if by chance the selection may have been too rigid, the smaller gangs, of which there is one on every division, are assigned to care for the occasional joints that require attention before another visit from the larger gang becomes necessary. This is done with only a

(Continued on page 84)

Manganese Trackwork Can Be Repaired By Welding

Experience of the Lehigh Valley, which has built up 350 turnout and 60 crossing frogs, demonstrates practicability of this method—New welding equipment ordered

THAT manganese trackwork can be repaired successfully by arc welding has been demonstrated on the Lehigh Valley. While recognizing that there is still room for further development, this road is so well satisfied with the results which it is securing that it is now providing itself with sufficient mobile welding generator equipment to make possible the field repair and maintenance of every unit of manganese trackwork on the system.

Difficulty of Repair Retarded Adoption

The history of the repair of common rail-steel crossing and turnout frogs by welding is possibly as inclusive and complete on the Lehigh Valley as on any other road in the country, and this road's early work in repairing frogs of manganese steel probably antedates that on most other roads. As early as 1920 this road was thoroughly organized and equipped to repair all of its common rail-steel crossing and turnout frogs, in the field, this being done by the oxyacetylene process. Each supervisor, of which there were 18 at that time, was provided with a complete welding and cutting outfit, and with a welder and helper who moved about over the road on a motor car, building up or repairing frogs and crossings.

Manganese steel had entered the trackwork picture some years prior to this time and the road had a considerable number of units of this material, but there were two distinct factors which mitigated against the more general use of this form of construction at this time, at least as far as the Lehigh Valley was concerned. The superiority of manganese construction was recognized, but it was more costly than standard rail construction and it could not then be repaired successfully.

Following the war the cost of manganese frogs and crossings rose to such levels that the road considered their purchase prohibitive and, as a matter of fact, actually stopped the purchase of all manganese track construction in 1917, except crossing frogs for points of heaviest traffic. If it had been possible to repair this class of construction, the initial cost would not have been so important, but without means of repair the point was reached where the increased service life of the manganese construction was not considered sufficient to justify its greater cost over that of common rail-steel frogs and crossings. The common rail units could be repaired by gas welding, but the manganese units, once worn, battered or defective in any way, had to be scrapped. As a result, the manganese units, to justify their increased cost, were left in the track until their condition was far worse than permitted with the rail-steel units.

Manganese Welding Developed Rapidly

As a result of this situation, the number of units of manganese trackwork on the Lehigh Valley was at a low level between about 1920 and 1926. In the latter year arc wedding appeared as a possibility in the repair of manganese steel. On the strength of this possibility the Lehigh Valley began experimenting with arc welding in manganese crossing repair and, at the same time, resumed the practice of purchasing manganese frogs for points where severe wear seemed to justify this construction. That progress in the welding of manganese steel was rapid and encouraging is seen in the fact that in 1929 the road gave up the manufacture of open-hearth rail-steel frogs and crossings and began to purchase manganese units exclusively.

At first the welding of manganese trackwork appeared to be a shop proposition, especially since it seemed impossible to provide trained forces on a division or subdivision basis. In 1927 the road purchased a 500-amp., d.c. welding generator, driven by a 47-hp. motor, which it set up in a small frame building at its Weatherly frog shop. This unit had three welding outlets in anticipation of large-scale operations, and it was planned eventually to bring all manganese frogs to this point for repair. After a few months of experimentation, this plan was put into effect, and all manganese crossing and turnout frogs requiring repairs were sent to Weatherly.

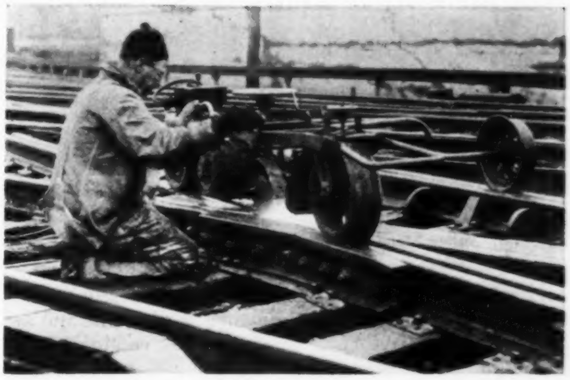
Here, one welder and one grinder, working under the supervision of the supervisor of the shop, did all manganese trackwork repair. All grinding was done in the frog shop proper by a seven horsepower Manhattan motor-operated rotary grinder, which was suspended from a chain hoist directly over a standard gage track. The units of trackwork were moved into the shop on push cars and were spotted directly under the grinder, which was then lowered into working position.

By the latter part of 1928 the road decided that most manganese turnout frogs could be repaired in the field, avoiding the expense of taking them out of the track and shipping them to the shop. As a result, it purchased a skid-mounted, d.c. welding generator of 200 amp. capacity, driven by a gasoline engine, which is moved from point to point on a flat car, setting it off with a locomotive crane near the site of each repair job. Crossing frogs, for the most part, were still sent to the shop for repairs, as were turnout frogs requiring more than the average amount of building up. By the latter part of 1929, however, many crossing frogs were also being repaired in the field and only those units with serious defects were sent into the shop for the more detailed work which this permitted without interference from traffic or hazard to train operation.

With approximately 140 manganese crossings and some 4,000 manganese turnout frogs on the road, it was evident that the single portable welding unit could not keep abreast of the repairs required. Therefore, last

year, when a decision was reached also to do a considerable amount of rail end repair by the arc-welding method, it was decided to equip each of the six main-line supervisor's territories with an arc-welding generator in order that each territory could repair and maintain its own manganese work.

Right—A Broken Point Before Any Attempt Has Been Made to Repair it. Below—Carefully Grinding the Point Before Welding



Dissatisfied with its first field unit, both from the standpoint of capacity to do the most effective work, and also by reason of its skid mounting which required that it be loaded and unloaded from cars by a locomotive crane, it was decided that the new generators should be mounted on self-propelled units. Further consideration indicated the desirability of a tractor mounting, which would make it possible to keep the welding units in close proximity to the work, especially rail end work, without the necessity of removing them from and replacing them on the track frequently.

With its own ideas of what the tractor mounting should be, especially in regard to width and height to permit operation along the shoulder of the track without interference with train operation, the road, under the direction of its supervisor of the frog shop and roadway tools, developed its own mounting. The resulting unit, which is described in detail in another article in this issue, was made to house the rearranged elements of the skid-mounted welding generator set which had been in service on the road.

As completed, the unit fulfilled expectations with the exception that it required greater driving power than was furnished, in order that it could cross and recross tracks with the greatest facility, and with the further exception that the 200-amp. welding generator did not develop enough arc heat under normal operation to produce the best welding results. The unit as a whole, however, demonstrated the practicability of the tractor mounting, and has been in continuous rail and frog welding service ever since its completion last summer.

As a result of the early experience with this unit, and, following through with its plan to equip each main line supervisor's territory with a welding generator, the road has recently placed an order with the Westinghouse Electric & Manufacturing Company for six tractor-mounted welding generators, similar to the experimental unit, but incorporating all of the improvements found desirable in that unit. The new units will have a 300-amp., direct current welding generator, which it is felt will be ideally suited for both rail end and frog work, as well as for welding in connection with bridge repair and strengthening.

The grinding of rail and frog welds in the field has, to the present time, been done with a Model P-8 Railway Track-work rotary grinder, which is mounted on three flanged wheels and is therefore, readily moved about on the job. In this type of grinder the grinding wheel can be moved longitudinally, laterally and vertically with respect to the work, so that in both preparatory and finishing grinding the specific cutting away or shaping desired can be attained. Grinders will be supplied to the different subdivisions along with the new tractor-mounted welding generators.

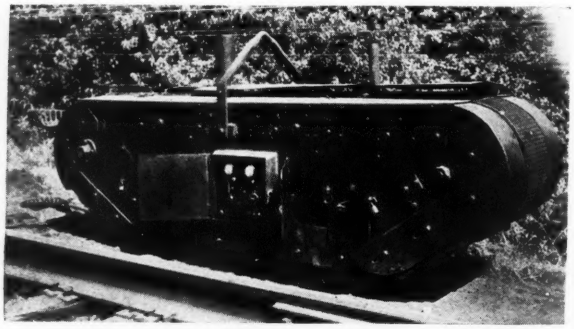
With the delivery of the new field welding units, which is expected early in the spring, the arrangement for making each subdivision responsible for all rail end repairs, as well as for the maintenance of all turnout and crossing frogs, will be put into effect. Only in the case of major defects will any special trackwork be taken from the track and sent to the frog shop for repair.

Above—A Welder at Work Building Up the Broken Point. Right—As the Finished Job Appears

In anticipation of the new arrangement, the most likely welding talent on the road is now being trained in best welding practices so that when the equipment is received the men can take up their work and carry it forward with the same degree of success that is being attained at the present time.

Many Difficulties With Early Welds

It is not to be understood that all has been successful in the welding of manganese trackwork on the Lehigh Valley, or that it is considered on that road that the ultimate in manganese welding has yet been attained. It is contended on that road, however, that present results highly justify the early experimental work done, and are sufficiently satisfactory to improve track conditions materially and to effect large savings annually.



The Tractor-Mounted Welding Generator Developed on the Lehigh Valley Stands Clear of the Track at All Times

Some of the earliest repair welds on the Lehigh Valley failed in service, the welds themselves cracking, and, in some instances, chipping off or actually coming out. The most serious problem was the breaking out of the weld metal. Almost invariably the breaks were immediately below the plane of cleavage between the base metal and the weld metal.

Many of the cracks which developed in the weld metal itself were found to be due to excessive peening of the metal during welding. At the time of the earliest experiments, the general opinion was that the character of the deposited weld metal was improved definitely in direct proportion to the amount of peening done. On this erroneous theory, the early welds were peened with an air hammer to insure that fatigue of the welder in peening with a hand hammer would not cause neglect of this important operation.

Failures of the weld metal peened with the air hammer led to examinations of the metal, which showed conclusively that excessive peening had broken down the metal in many cases, filling it with small cracks which grew and opened up eventually under the further pounding of traffic. As a result, air hammer peening was given up for peening with a one-pound hand hammer, which, if used conscientiously, was found to produce good results without undue fatigue of the welder.

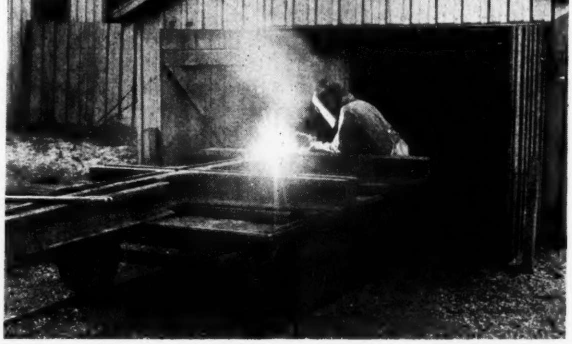
Early Welding Rods Unsatisfactory

In the early attempts to weld manganese steel, a straight manganese steel welding rod, containing 12 to 15 per cent of manganese, or the approximate manganese content of the work to be repaired, was the highest development of the welding rod. The use of this rod seemed logical on the assumption that the weld metal should have the same physical characteristics as the base metal, but tests and experience showed that the straight manganese rod, containing no other alloy, was not producing the desired results. In fact, it became evident that the necessary welding heat in applying this rod metal was contributing largely to the damage to the base metal adjacent to the weld metal. Furthermore, through oxidation during welding, it was found that a considerable amount of the manganese of the rod was lost, bringing the deposited metal into the range of low manganese content, which does not possess the strength and toughness of manganese steel with the correct amount of manganese.

To overcome this latter disadvantage, straight manganese steel rods were developed with a coating of material which formed a liquid slag over the deposited metal and minimized the loss of manganese, and also carbon, from the metal through oxidation. In spite of these improvements, straight manganese welds were far from satisfactory for repairing trackwork, although for lack of something better, they were used until 1929, when nickel-manganese rods were introduced by the welding industry. These rods, the content of which is essentially 60 to 80 per cent carbon, 13 to 15 per cent manganese, and 3 to 5 per cent nickel, proved far superior to the straight manganese rods, producing a strong and tough weld metal without the necessity of water quenching. Furthermore, it was found that the nickel in the rods permeated the transition zone in the base metal immediately beneath the weld, greatly reducing the harmful effect of overheating, which, with the straight manganese rods, was causing fractures in this area.

Frogs Are Touched Up Periodically

The Lehigh Valley started to use nickel-manganese rods in the summer of 1929, and, to a large extent, its success in welding manganese track castings dates from that time. In subsequent years, several hundred turnout and crossing frogs have been repaired or built up successfully, some three or four times, each time extending the life of the frogs from 9 to 18 months. The policy of the road, which will be followed out to its fullest extent with the delivery of the additional welding generators ordered, is to keep all of its manganese frogs in good condition, never allowing them to become worn to any great extent.



Repairing a Badly Damaged Crossing Frog at the Road's Frog Shop at Weatherly, Pa.

That this policy has been in force with respect to some of the most important crossings on the road is evidenced in the history of these crossings. For example, in the case of the double-track main-line crossing of the Lehigh Valley with an interchange track of the Pennsylvania at

Phillipsburg, N. J., the present manganese crossing frogs were installed new in July 1925. By the latter part of July, 1931, they were well on their way to destruction, and, ordinarily, would have had to be replaced. On July 30 repair of the eight crossing frogs by welding was started, the work requiring three days. In February, 1932, the points were again touched up, the work this time requiring only two days, and on December 30 last all eight frogs were gone over once more and restored to their original condition. In this latest work, three days' time of a welder and a helper were required. Thus, the eight frogs of this crossing, under heavy main line traffic, are in excellent condition after approximately eight years of service. The total welding expense in connection with the maintenance of these eight frogs has been less than $300, or approximately one-fifth of the original cost of one of the crossings.

If it had not been for the welding repair work done, it is estimated that these crossings would have had a maximum life of only about six years, with the latter half of this life presenting anything but the best of track conditions. Just what the ultimate life of the two repaired crossings will be is a matter for conjecture, but it is felt that they will last for some years to come, with an expenditure of not to exceed $50 a year for each crossing during this period.

Success Depends on Several Factors

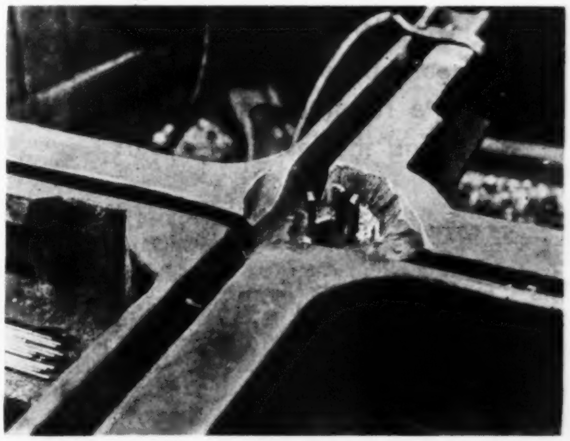
The factors involved in the successful welding of manganese trackwork have been found by the Lehigh Valley to be analogous to those involved in the proper filling of a decayed tooth; that is, proper cleaning of the cavity, proper application and anchoring of the new metal, and proper grinding or polishing of the new metal to the correct level. The work involved in the preparation of the base metal depends entirely upon its condition, from the simple operation of grinding a worn or distorted surface to that of burning out sizeable areas

A Double-Track Crossing of Main-Line Track Which Has Been Maintained in Good Condition by Electric Welding

of cracked or spongy metal. Most frog points which are merely battered down or chipped can be prepared by simply grinding away all oil, dirt and rust from the surfaces to be welded, as well as any of the old metal which has been forced outside the desired limits of the finished work. Where cracked or soft metal is encountered it must be removed. This is done more rapidly with a gas cutting torch than with a grinder, but if a torch is used to speed up the work, the final surface is ground away to a depth of at least 1/32 in. to remove any metal which may have been damaged by the heat of the torch flame.

The question of whether all loose or soft material has been removed from a break or fault in a frog casting is often a difficult one, but the presence of underlying breaks or bad steel is usually made evident to the experienced welder by one of three tell-tales; the sound of hammer blows, the sound of the grinding wheel, or spots or fringes in the metal which become heated to incandescence during the grinding operations.

With the assurance that the surface to be welded is clean and sound, the weld is made. The specific method of making the welds varies in many respects with the size



Bad Metal Necessitated Cutting this Large Cavity From a Damaged Crossing Point—Inserts of Mild Steel Have Been Welded in the Cavity to Insure Positive Anchorage of Weld Metal to the Base Metal

of the cavity or the character of the repair to be made. In all head welds or cavities less than ¾ in. in depth, nickel-manganese rods are used for weld metal, but in large deep cavities or holes, the lower part, to within ½ or ⅝ in. of the surface, is filled with a five per cent nickel-steel rod, the rod used by the Lehigh Valley in its rail end work. This rod is cheaper than the nickel-manganese rod and appears to give satisfactory results where the metal deposited is essentially for filling purposes.

In filling some of the larger cavities or holes which it has been necessary to make in certain frog castings to remove bad steel, the Lehigh Valley has actually used metal filler pieces or inserts, surrounding them with rod steel and thereby making them integral with the casting itself. One of the accompanying illustrations shows such a situation. Here, four pieces of ⅜-in. by 1½-in. mild steel bar were welded upright in the cavity, with the dual purpose of saving in rod steel and of anchoring the weld metal securely to the base of the frog casting. The anchor feature was considered particularly desirable in this case because of the large size of the cavity and the possibly dangerous condition which might result if the entire deposit of weld metal should be broken out under the pounding action of traffic.

Special Technic in Applying Metal

In the actual welding operations, the rod steel is deposited in a series of beads from ⅜ in. to ¾ in. wide and from 5/32 to 7/32 in. high, depending upon the diameter of rod used. The metal, in any case, is puddled as it is laid down, by imparting a weaving motion to the rod electrode. Before any part of a weld head cools beyond red heat it is peened with a one-pound hand hammer, usually to the extent of reducing its height by about one-fourth. A 3/16-in. rod has been found best adapted

(Continued on page 84)

Pennsylvania Arc-Welds Crossings by Contract

Life of some 300 crossings in the Western Region has been appreciably extended as a result of repair work during the last three years

A Crossing Frog That Has Been Repaired by Arc-Welding

BECAUSE the application of arc-welding of manganese trackwork received a considerable impetus through development work carried on by contractors, it has been the policy of a considerable number of railways to handle the repairs of all or an appreciable portion of their manganese frogs and crossings under contract. The following account of the practices of the Western Region of the Pennsylvania in the handling of the repair of manganese steel crossings, serves as an excellent example of methods and procedure and of the results obtained in the application of this new process for the conservation of a valuable and important material.

In Use About Three Years

The electric arc-welding process has been employed in the repair of manganese trackwork in the Western Region of the Pennsylvania for about three years, work on crossings being done in track by contractors, while manganese insert turnout frogs are, in most cases, repaired at the maintenance of way shop at Chambersburg, Pa. The reasons for this difference in practice are obvious. Crossings, unlike frogs, can ordinarily be used only in the location for which they are designed and built, and cannot be taken into stock for reissue; also the cost of removal and replacement is much greater.

The practice of repairing crossings on the Pennsylvania had its inception as an experimental effort to save the cost of a new crossing that had been recommended for inclusion in the budget. In the Western region such a trial repair was made under contract early in 1930. Similar work was subsequently done on a few other crossings, and with the establishment of specific data on the crossings thus repaired, the practice was extended so that up to the end of 1932, or within a period of three years, contracts embracing work on approximately 300 crossings had been carried out, this number embracing repeat jobs on not a few installations on which work had been done previously.

This rapid extension of the application of electric welding to manganese crossings has its foundation in the ease with which it has been possible to check the economy of the work done. Service records afford reliable data on the life of crossings in any location, in terms of traffic, or—during periods of fairly uniform traffic—in terms of months. This, then, affords a measure of the rate of depreciation, and if the anticipated life of a crossing as the result of repair work can be obtained at a cost no greater than the proportionate loss of value of a new crossing in the same period, the cost of repairing the crossing is fully justified. Moreover, it is the experience in the Western region of the Pennsylvania that repair work can be done at a considerable margin under the corresponding service cost of a new crossing unless the deterioration of the old crossing has gone too far. This contingency, however, is readily checked under the procedure followed in awarding contracts for arc welding work.

Projects for repairing manganese crossings originate with the division organization and recommendations for such work are submitted by the division engineer to the chief engineer maintenance of way. Contractors are then invited to send representatives to inspect the crossing, in company with the division engineer or some member of his staff, for the purpose of ascertaining the practicability of the proposed repair work and of obtaining the necessary data upon which the contractors may base intelligent bids.

Avoid Uneconomical Work

The practicability of undertaking the repair of a given piece of manganese work has been placed under rather definite control by reason of a practice that has grown out of experience in contract welding, namely, a stipulation in the contract that the welding concern will guarantee the work for 90 days. This has proved satisfactory to both the railroad and the contractors because it has been found that if the repair work will stand up for three months it is reasonably certain to give good service for the anticipated period. At the same time, however, it puts the contractors on their guard not to undertake work, which, on the basis of their experience, is not likely to prove successful.

This phase of the problem is discussed on the ground and if the contractor's representative declines to guarantee the work, it is ordinarily not undertaken. As a matter of fact, since the welding of manganese work has been thoroughly established, every effort is being made to repair defects before serious damage has been done. In a few cases, repair work of questionable reliability has been authorized to carry over crossings until new ones could be installed. Contracts are awarded on the basis of sealed bids filed with the chief engineer maintenance of way.

Experience in the Western region of the Pennsylvania indicates that defects in manganese steel trackwork may be classed under four primary heads—batter, crushing, faulty metal, and cracks. Batter represents the ordinary effect of traffic and calls for the simplest form of corrective work, namely, the building up of the running surface to the required elevation. Crushing occurs most commonly at the corners where the flangeways intersect and is the result of the pounding of the wheels in jumping the flangeways. This, like cases of defective metal, requires the removal of parent metal to whatever depth is necessary to reach sound metallic structure. Cracks are of two general types—transverse and longitudinal—the former commonly occurring at the intersections, starting at the base and continuing up the side walls, while the latter are found most often in the flangeways. The closing of cracks presents the most difficult problem encountered in the repair of manganese work, and has given rise to a considerable difference of opinion as to the effectiveness of corrective measures, especially as it concerns flangeway cracks. However, it is agreed that the metal must be removed to the bottom of the crack or, if the crack extends through the section, a sufficient gap must be cut to provide ample width for an effective weld.

The application of the welding process to manganese steel was not perfected until long after the welding of open-hearth carbon steels had proved highly successful. This is explained by the peculiar metallurgy of the former, which long defied the welder's efforts. While there are still differences of opinion as to what takes place and different welding concerns have their own ideas and methods, certain general rules have been evolved that are now accepted as essentials to success.

Requirements for Good Work

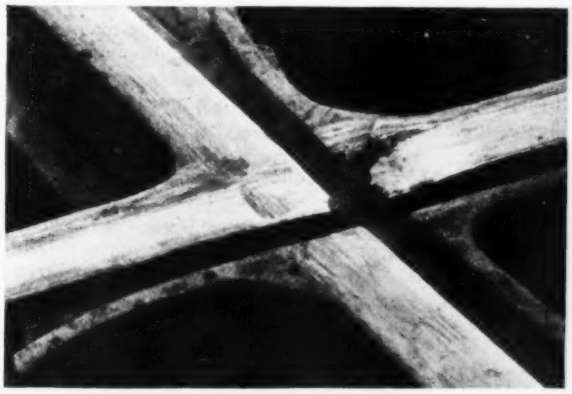
Foremost among these is the requirement that the parent metal must not be appreciably heated, first, because the attainment of a temperature in excess of about 800 deg. F. results in a breaking down of the characteristic austentitic structure of manganese steel upon which its essential qualities of toughness and strength are founded, and second, because dependence must be placed largely on the quenching effect of the cold parent metal to develop the corresponding austentitic structure in the weld metal applied. This is the primary reason why electric-arc, rather than gas welding has been required on manganese steel and why contractors and others who are engaged in this work have developed a special technic and, to a considerable degree, have employed special equipment for this type of welding. For example, the contractors who do the greater proportion of this work do not permit a gas cutting torch to be used for the removal of defective metal. Instead, this is done whenever possible with grinders, and where grinding is not practicable, arc-cutting rather than gas cutting is resorted to and this must always be followed by grinding to remove all burned or overheated metal.

The same rule effects the selection of the generator unit and the size of welding rods. As the welding current should not exceed 120 to 125 amperes on manganese work, it is considered best practice to provide generators with capacities limited to 200 amperes or preferably 150 amperes, thus relieving the welder of any temptation to use a heavier current and thus introduce the hazard of overheating the parent metal. This consideration also governs the size of the welding electrodes—which should not exceed 3/16 in. in diameter, with opinion favoring as small as 1/8 in. diameter for beads in the bottoms of cavities. The welders are also required to exercise caution in applying the new metal to avoid the application of heat too long at one point. In other words, it is deemed best practice to move the arc from one location to another as soon as a minimum bead has been produced. By far the most important element in the success of arc welding of manganese crossings is the skill of the welder. Long training is required to insure proficiency. The quality of the work is influenced in no small measure, also, by the training the welder has received in the use of the peening hammer. Practice in this regard varies with different concerns, but it is rather definitely established that excessive peening must be carefully avoided.

Choice of Electrodes

Opinions differ as to the type of electrodes to be used, the selection depending in part on whether direct or alternating current is employed, this also being a matter subject to divergent views, although it is evident that good results are obtained with either. However, the selection of electrodes is an exceedingly important factor in the character of the results obtained and it does not follow by any means that work done with more expensive welding rods will cost any more than if cheaper rods are employed.

Grinding has an important place, also, in the finishing of the job as all running surfaces must be ground to a true elevation, and flangeways must be squared up. There is room for considerable discrimination in the selection of grinders and grinding wheels and, while a contractor's grinding equipment has some influence on the quality of the work, its greatest effect is in the economy with which he can carry out this feature of the process.



Example of a Broken Manganese Frog to Which the Arc-Welding Process Is Applicable

For prompt movement as well as for maximum convenience, contractor's welding outfits are usually mounted on motor trucks. It is usually possible to drive within 100 ft. or less of a crossing, but to take care of exceptional cases one contractor mounts his motor generator sets on skids so that they may be transferred from the truck to a push car, if necessary, although this necessitates removal from the track at the job. In addition to the generator, the outfit includes grinders for both surface and cross grinding, which, as they are usually motor driven, demand a source of current supply other than the generator supplying the low-voltage welding current.

(Continued on page 86)

Operator Welding a Battered Rail with the Electric Arc

Building Up Rail With the

An account of the details of inspection, preparation and workmanship that are employed on the New York Central to obtain the maximum benefit

A MARKED increase in the hardness of the rail ends, a complete absence of failures and a practically complete absence of batter after more than 2½ years of service, together with an estimated extension of six years or more in the service life of the rail under heavy traffic are outstanding results of a program of reconditioning battered rail ends by electric arc welding which the New York Central Lines commenced in 1930. Other features of interest include the preliminary inspection of the rail that is to be treated, the requirements with respect to workmanship and the system of inspection of the finished work that have been followed by the railway. To date, all of the arc welding on this system has been done by contract. While no specifications were prepared for the guidance of the contractor, certain requirements which are considered essential are enforced and the contractor and the maintenance officers of the road have worked in close harmony to insure that maximum benefits will be obtained in added life for the rail, smooth-riding track and aid in improving maintenance conditions.

Batter Is Practically Eliminated

To insure that no essentials are being overlooked, a check has been kept of the performance of the reconditioned rail ends. After more than 2½ years, one stretch of 14 miles of track which was built up early in 1930 showed an average of less than 2 chipped ends to the mile. Of these, 10 showed up within less than a year and only 3 were of importance with respect to size. Spot checks on batter have indicated that approximately 80 per cent of the joints have no discernible batter after this interval, and that where batter has occurred it is generally less than 0.01 in.

On work completed in 1931, there are 2 slightly chipped ends in 32 miles of track after more than one year of service, not of sufficient consequence, however, to require any action. Batter measurements show substantially the same results as those on the 1930 rail.

From present indications, it is estimated that the present life of the rail, so far as this may be limited by the development of batter, will be extended at least six years and probably more. While this estimate is based on the results so far obtained, there is no reason to believe that the joints cannot be rebuilt a second, or even a third, time if necessary, each operation extending the life of the rail for a corresponding period.

Although no definite figures as to savings in maintenance are available, observation indicates that before this reconditioning was done, there was much churning at the joints, as shown by the muddy condition of the ballast. Since the welding was done, there is evidence of greater stability of the ballast, and the joints are being maintained to surface with less effort, while it is certain that smoother-riding track has been secured.

Prior to 1930, one or two units of the system had done some welding of rail ends, but the work had not been co-ordinated. During this time it was the usual practice to make a selection of the individual joints to be reconditioned and do spot welding generally. Since 1930, however, no spot welding has been done, every job being completed out of face.

While experience had demonstrated that this method of reconditioning the rail ends corrected the trouble for a time, a thorough investigation of the whole subject of rail wear, batter and welding led to the conclusion that the welding practice to be described offers a means of extending the life of the rail for a longer period. This conclusion was reached only after an inspection had been made of the welding practices and results on a number of representative roads, and correspondence with several maintenance officers experienced in welding rail ends. As a result of these investigations, it was decided to undertake arc welding and the first program was prepared for 1930, in which year 14 miles of track was reconditioned in this manner. The results were so satisfactory that this was followed by a second contract for about 76 miles in 1931.

Preliminary Inspection Is Considered Essential

To determine the progress of batter, a careful preliminary inspection of the rail on each division and a check of the track are made from year to year. Upon this inspection, which is made by the local maintenance officers, are based the recommendations, if any welding is necessary for the following season. These recommendations are supplemented by information as to the age of the rail; the amount of head wear; the prevalence of corrugations, end batter, flowing, and surface and line bends; and other data on the general condition of the rail.

After the recommendations have been assembled and a tentative program has been prepared, a further and more detailed inspection is made of the sections included in this program, by either the maintenance of way forces or the inspection department. This inspection, which is concerned primarily with wear, also includes a check of all or portions of the track, as may be considered necessary, for batter, using 12-in. or longer straight edges and wedge and feeler gages. The usual practice is that if 50 per cent or more of the rail is battered 3/64 in., or chipped to any extent, the track involved shall be included in the welding program. Furthermore, if welding is necessary on 50 per cent of the rail ends, the remainder will be battered to some extent and it is con-

Ends Electric Arc

sidered more economical to do the work out of face than to do spot welding.

So far, all of the electric welding has been applied to rail during the first cycle of its service life, and after about eight years of service. As yet no relaid rail has been welded, but consideration has been given to the question of rebuilding the ends of released rail at the time it is relaid. All of the rail so far treated has been in single or double track which carries both passenger and heavy freight traffic.

First Welding Was on 105-Lb. Rail

The first arc welding was done on 105-lb. rail in a single-track line which carries an exceptionally heavy coal tonnage. After this rail was laid, the normal follow-up maintenance work had been somewhat deferred, particularly the installation of stone ballast, which is essential on a line having a traffic of such density and weight moving over it. Similar stretches of track were cared for subsequently, in which the conditions with respect to original installation and subsequent maintenance were nearly identical.

Before the work was started, there were no set arrangements as to the methods to be followed, but only with regard to the results that were desired. For these reasons, no formal specifications were prepared. Through conferences with the contractor, however, a working basis was developed and agreement was reached on certain items that would be required, including details of finish. As the welding progressed, it was arranged to make a current inspection of the work, checking both workmanship and finish.

Among the essential requirements, it was agreed that the depression formed by the batter or chipping should be completely filled and the surface of the new metal ground level or not more than 0.005 in. high. Another requirement is that the radius of the head at the weld must conform closely to that of the body of the rail. The welds are required to be virtually free from blow holes, cracks and other defects. Particular attention is directed toward having a uniform junction between the original metal in the rail and that of the weld, avoiding a sharp or irregular line of demarcation at the end of the weld. If there is a bead on the gage corner of the rail head, no attempt is made to include a similar bead on the new metal, but care is exercised to avoid having the gage corner ground back excessively. Care is also exercised to avoid dropping metal into the joint gap, since it is quite likely to interfere with the normal expansion of the rail. The proper degree of hardness in the welded metal is considered essential to success in welding, and special efforts are directed toward attaining uniform hardness of the proper degree.

Surface and cross grinding are considered equally essential to a satisfactory job. The finished surface is required to be smooth, level and at the same elevation as the adjacent running surface. Cross grinding is required to remove completely any overflow at the rail end, but excessive beveling is not acceptable, while the bevels are required to be straight and at right angles to the longitudinal axis of the rail.

In the conferences to develop a working basis, it was emphasized that all work must be done properly in the first place. This feature is never lost sight of by either the contractor or the railway, since it is considered that corrected work is not likely to be to the same standard as work that is done properly in the first place.

Equipment and Organization

The contractor's equipment for one gang consists of a gas-driven power plant comprised of two A-C. generators, a surface grinder, a cross grinder, a preheater, the necessary welding tools and incidental equipment and an electric lighting plant for night work. The welding current is supplied from a constant-current, 350-ampere, 120-cycle generator, while the grinders are supplied with power from the second set which generates constant voltage at 60 cycles. Through the use of high primary voltage, the welding can be carried on continuously for a distance of 3,000 ft. on either side of the power plant. The transformer steps this line voltage down to 60 volts, open circuit, the drop across the arc being 42½ volts with slight variations.

The surface grinder, which is equipped with two 2-in. by 14-in. high-speed grinding wheels, one for each rail, is operated by a 5-hp. motor. The cross grinder is now mounted in a rigid frame, which clamps to the rail, to hold it in position and control the movement during the chamfering operation. The chamfering wheels are 8-in. in diameter, but the width varies with the wishes of the engineer in charge. For reasons of economy, however, the contractor prefers to use a width of 5/32 in. It is of interest that since the frame came into use not only have the bevels been more uniform, but the cross-grinding costs have been reduced by 50 per cent.

A welding gang consists of a supervisor, 1 welder, 1 helper, 1 surface grinder and 1 plant operator. The

Top—A Battered Joint Before Welding. Middle—The Completed Weld. Left—The Same Joint After Grinding and Chamfering

work is carried on in two shifts, the supervisor being in charge of both crews. He inspects the joints, marks the limits of the welds and cuts out all damaged or fatigued metal in advance of the welding. He also carefully inspects the completed work and marks for correction any joints not up to the required standard. The helper assists the welder and operates the preheater, which was described on page 735 of the December issue. Since the chamfering requires a relatively small amount of time, the plant operator is able also to care for the cross grinding.

Only experienced operators are employed. They have been able to average slightly more than 50 joints per man a day, although this number depends on the length and depth of the welds and the number of interruptions from traffic. During the two years under review, the welds averaged about 9½ in. in overall length, requiring the application of 18 oz. of metal.

Inspection of the Finished Work

When inspecting the finished work, the supervisor of welding representing the contractor accompanies the railway's inspector. They examine every joint, chalking on both the joint and the tie any faults of workmanship or other corrections that are found, using a 20-in. straight edge to determine whether the depression has been filled and properly ground. Heavy gouges by the surface grinder are not permitted. Material from the welding which may have dropped into the joint gap is marked for removal. A second inspection is made of the corrected work.

Cross grinding is inspected carefully for uniformity of depth and width. At the beginning, the cross grinding was done by hand with no mechanical guide to insure uniformity. The result was that the grinding was not always done square with the rail, while the corners were sometimes rounded. To overcome these variations and eliminate the rounded corners, a frame was devised to hold and guide the grinding wheel.

Hardness Tests Made with Rebound Scleroscope

The inspector is equipped with a scleroscope to make rebound tests on representative joints rebuilt by each of the operators in a gang. This instrument is preferred to a portable Brinnell outfit, because it permits the inspector to make a number of check readings on any one joint. In general, the scleroscope readings on the normal rail metal in tangent track, after it has been subjected to the cold-rolling action of the wheels, are 38 to 40, corresponding to a Brinnell hardness of about 260. One objective of the welding is to obtain a surface hardness of 50 to 55, corresponding to about 325 to 350 on the Brinnell scale. The metal at the junction between the weld and the original metal of the rail at the end of the weld invariably runs from 10 to 15 points higher on the scleroscope scale, equivalent to 390 to 400 Brinnell. Apparently this variation cannot be overcome, since the smaller mass of metal applied at this point in a relatively thin film cools more rapidly than the larger mass toward the end of the rail.

In this connection, the question at once arises whether the greater hardness of the applied metal, particularly that at the junction, will promote secondary batter back of the weld. This has been watched carefully and in two years only a few such cases have developed, most of which can probably be traced to other causes. In the few cases where there are indications of secondary batter back of the weld, the depressions do not exceed 0.003 to 0.004 in. On the whole, it can be said with some degree of positiveness that there are no indications of a tendency toward secondary batter as a result of the greater hardness of the welded metal. In fact, it is believed that practically all of the cases that have been found have been traced to improper runoff between adjacent rails of unequal height or to failure to grind the added metal down to the normal elevation of the rail.

While a degree of hardness represented by readings of 50 to 55 with the scleroscope is sought, it should be understood that the hardness actually attained in practice varies over a considerable range, even in adjacent joints which have been built up with exactly identical materials and by the same operator. The cold-rolling action of the passing wheels eventually raises the scleroscope hardness above that which is recorded immediately after the weld is completed, however, so that in only a few instances is the final hardness below the required standard.

Cases have occurred where the hardness has been too low, and rewelds have been found necessary. In these cases, a small amount of additional metal has been applied and ground down, the reheating of the welded metal apparently restoring the hardness. This feature has been given particular attention, in an effort to improve the average work, to restrict the range over which these variations occur and thus increase uniformity.

Degree of Hardness Influenced by Several Factors

The degree of hardness that may be expected in this type of weld is influenced by a number of factors, the first and most important being the ability and skill of the operator. The intensity of the arc, the rate of application and the depth of the metal applied also influence the final result. The type of rod has a very direct effect on this result, however, being about equal in importance to the skill of the operator.

It has been the experience that satisfactory results are to be obtained by using a welding rod of alloy steel containing about 5 per cent of nickel. It has also been found that a heavy coating of the proper composition is invaluable for fluxing the metal, controlling the fluidity and puddling during application. Experience elsewhere has indicated that the use of inferior rod material should be discouraged, since only by employing high grade material can maximum service life be obtained from the welds. In the judgment of the officers of the New York Central, the extra hardness obtained through the use of the proper grade of welding metal and by careful methods of application is invaluable as insurance against the subsequent development of batter.

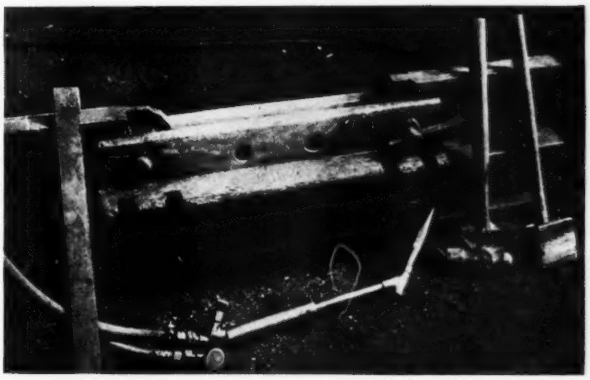
In the investigations that are being made prior to the welding, it has been found that where three-tie supported joints are used, the percentage of rail ends that require batter correction is low. On most of the rail that apparently is battered, the application of reformed bars eliminates about half of the apparent batter. This usually corrects the out-of-level condition of the rail ends, and brings them back into the same plane. Apparent batter as great as 3/64 in. has frequently been found to be in reality the result of a loose fit of worn angle bars. It has also been determined that if the rail has been installed properly when it is laid, with careful attention to tie spacing, surfacing and lining, the need for building up the rail ends is definitely deferred and in many cases eliminated. Another item of interest is that in practically all cases the average head wear on rail that is battered enough to require welding varies within narrow limits, ranging from 1/32 in. to 7/128 in.

Out of the experience of the first year it became ob-

(Continued on page 79)

Can Angle Bars Be Built Up?

New Haven restores more than 200 track miles of joints by welding in 1932 and plans to continue work on large scale



Above—A Welder, Restoring a Pair of Worn Bars. Left—Close-Up of a Pair of Repaired Bars, Cooling in the Bar-Holding Jig—Also Welder's Tools

THE New York, New Haven & Hartford believes that economy is derived, without detriment to the track structure, through the building up of worn rail joint bars to compensate for the wear on the bars themselves and on the fishing surfaces of the rail. Evidence of this is afforded by the fact that after several years of what may be called extensive tests, this road is now continuing a program of bar reclamation which resulted in the building up of more than 200 track miles of joint bars in 1932, and more planned for this year.

This class of work on the New Haven is the outgrowth of success in the building up of rail ends, frogs and switch points by gas welding, and belief that the building up of battered rail ends without giving attention to worn joint bars in connection therewith is inconsistent and uneconomical. As a result of this belief, the New Haven has in recent years given more attention to joint bars than to rail ends, and, even during the present year when it is expected that a considerable mileage of rail ends will be built up, it is planned that this work shall be preceded by the repair of the joint bars. From its first experiments, it is said, the reclamation of bars has been uniformly successful, with failures or unsatisfactory conditions occuring no more frequently in the reclaimed bars than in bars which have not been welded.

Built Up to Average Fit

Experiments with the building up of angle bars were started in a small way in 1925. Gradually test installations increased and, as they began to show the results desired, the practice of building up bars spread from division to division until all divisions on the road were carrying on this class of work to at least some extent. In 1932 the work of the different divisions was put on a program basis, prepared under the direction of the engineer maintenance of way, and, future work will undoubtedly continue on this basis. During 1932, joint bar reclamation was carried on at 20 points on the road, employing from 60 to 65 welders and a number of helpers continuously.

Except in the case of the earliest experiments, the work of bar reclamation on the New Haven has been of the same general nature. All of the work is carried out, under cover, at points especially equipped to make possible its execution with the greatest facility and economy. Field work, with an attempt to provide a "tailor made" fit for each bar was discarded after first experiments as impractical and prohibitive from a cost standpoint. At the central welding points there is no moving or shifting of the heavy bar-holding jigs necessary to the welding operations, and a minimum of handling of the gas containers. Furthermore, at a number of the reclamation points, the acetylene gas used is generated on the ground in plants installed and operated by the Oxweld Railroad Service Company. This, of course, provides for the most economical operation since it eliminates any charges for the handling, transportation and storage of cylinders.

While a custom fit of the welded bars to the rail is considered ideal, it has been demonstrated as not essential to good results. The nearest approach to securing such a fit is to determine, by field measurements and trial bars, the average bar and rail fishing wear in the territory to receive the built-up bars, and then to build up all of the bars for this territory to the average height and contour required. Where the rail is all of a specific year and has been subject to the same tonnage and standard of maintenance, the amount of bar and rail fishing wear is quite uniform at the different joints. As a result, bars built up to meet the average condition have quite generally proved effective on all joints.

The bars repaired thus far on the New Haven have all been of the untreated angle bar type, 24 in. long and with four bolt holes. These bars have come mostly from 80, 100 and 107-lb. rail. Some of the lighter bars have been in service since 1890, but the 107-lb. bars being

repaired have been in service only 6 to 12 years. Since 1926, the standard rail section for main line tracks has been 130 lb., but none of the bars used with this heavy section have been built up as yet.

Until last year, reclaimed bars were used only in branch line main tracks or tracks of less importance, but during 1932 a large number of main line bars were built up and reapplied in the same general main line territory from which they were removed. It is understood, of course, that the reclaimed bars are used only with worn rail. A large part of the present year's program, which

Three Welders, Building Up Joint Bars in the Shop at New Haven

includes approximately 120 track miles of joints on the Hartford division, between New Haven and Springfield, Conn., will involve the building up and reapplication of the original bars to the track, without disturbing the rail other than to build up the ends by welding where this is found to be necessary.

Bars Turned to Balance Wear Conditions

Examination of worn joints on the New Haven has shown that the combined wear on the bars and fishing surfaces of the rail varies widely with the life of the track, the tonnage handled over it, and the standard of maintenance which has prevailed, but that this combined wear, so far as those bars which have been removed for building up are concerned, has averaged from 0.060 to 0.090 in., with the slightly greater wear on the bars. It has been found that the top bearing of the bar and the rail head fishing on the receiving end get greater wear than on the leaving end, this applying not alone to the depth of wear, but also to the lineal distance over which it is spread. More specifically, whereas perceptible wear on the leaving end of the bar head and rail fishing rarely extends over a distance greater than three inches from the center of the bar, that on the receiving end of the bar head and corresponding rail fishing surface usually extends a distance of six or seven inches from the center of the bar. It has also been found that there is some perceptible wear on the bottom of the base of the bar and that this wear is greater on the leaving end.

With this condition prevailing, the road has found that in addition to applying weld metal to the top of the bar, it is desirable to turn the bars, end for end, in their reapplication; that is, inside bars become outside bars, and vice versa. This reversal of the bars distributes the wear at a joint more evenly and necessitates the addition of less metal to the tops of the bars to compensate for the wear in the fishing surface of the rail and on top of the bars. Furthermore, through this redistribution of wear at the joint, the application of reversed bars has a leveling influence on the rail, tending to pull the leaving, or high rail down, and the receiving or normally low rail up.

The equipment used in welding angle bars at the different reclamation points is essentially the same, consisting of bar-holding jigs, acetylene torches, and peening and flattening hammers. At several of the reclamation points sufficient equipment is provided to permit 12 welders to work at a time, while at other less important points the set-up is limited to the extent of providing for the employment of only 3 welders.

The bar-holding jig permits the bars to be mounted in pairs in the position they occupy in the track, but with the entire center section of their heads exposed for welding. This jig is a home-made arrangement of old rails, consisting essentially of a support rail, inverted and set several inches off from the floor, and a bar-hanging rail, in upright position, resting directly on the inverted base of the lower rail, to which it is clamped. There is nothing unusual about the support rail, but the bar-hanging

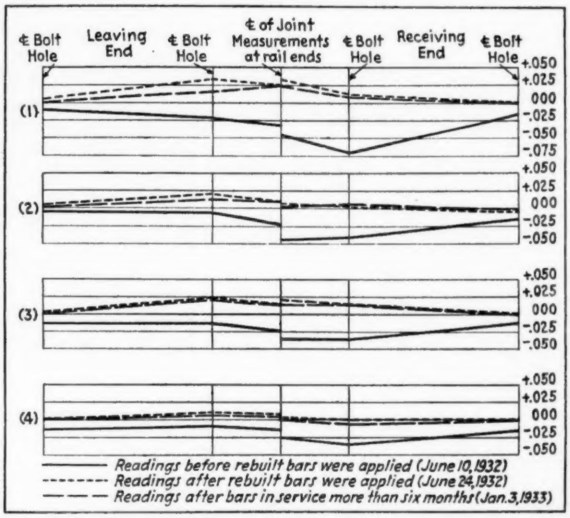


Chart Showing Graphically Joint Conditions at Four Joints Before and After Built-Up Angle Bars Were Applied

rail, which is drilled with bolt holes corresponding to the drilling of the bars, has its head and the upper part of its web cut away between the inside limits of the outer bolt holes. Thus, when the pair of bars to be repaired is bolted in place through the end bolt holes, the entire center portion of the bar heads is exposed to the welder.

To facilitate the application and removal of the bars, key-bolts are used, in which the driving of a wedge-shaped key through a slot in the bolt forces the bars inward against the rail. As the bars are hung in place, a 1/16-in. metal shim, about three inches long, is placed directly under the base of each bar at the center. These shims cock the bars upward slightly at the center as they are applied, and thereby overcome the tendency of the ends of the bars to curve upward as the weld metal placed on top of them cools and contracts.

The extent and height of the welds to be applied to bars are determined from wear measurements taken in the field. For example, if a 10-mile stretch of bars is to be built up in a territory where conditions are such as to cause one to expect fairly uniform bar and rail fishing wear, the bars are removed from four or five joints selected at random, and the wear is measured. From these measurements a bridge straight-edge, 18 in. long, is made up, which shows the welders the exact height

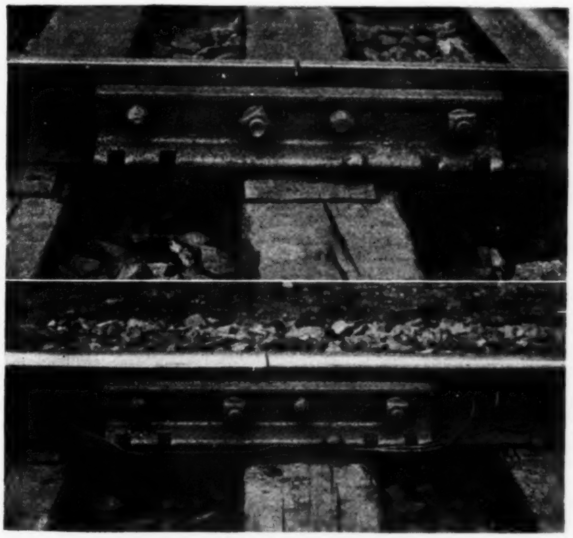
to which the bars must be rebuilt. This straight-edge takes into consideration the expanded condition of the weld metal when the straight-edge is used by the welders, and also the excess height desired in the bars to compensate for the wear in the rail head fishing surfaces.

Using this specially prepared straight-edge, the test bars removed from the track for measurement are built up. They are then reapplied in the field, without consideration as to which of the five joints they were removed from, and the resulting condition as regards fit is observed. If the fit is found to be uniformly satisfactory, the straight-edge, as designed, together with duplicates of it, are used in building up all of the bars in the section of track under consideration. If, on the other hand, the bars do not have a satisfactory fit, they are altered as necessary and corresponding changes are made in the straight-edges.

Details of Making Welds

There is nothing unusual about the actual welding operations or the welds themselves. The welder, who sits alongside the work, builds up one bar at a time in much the same manner as in making any gas weld. Peening and shaping of the weld are done with an ordinary machinist's hammer and a flatter having a face about 2½ in. square. The welding rod used is ¼ in. Maintenance of Way steel as furnished by the Oxweld Company, which produces a weld much harder than the bar steel itself.

The amount of weld metal applied to a bar depends upon the amount of wear, both as regards depth and extent. Ordinarily, owing to the excess wear found on the receiving end of the bars, the weld on this end extends from 7 to 7½ in. from the center of the bar. On the opposite end, the weld is usually limited to 2 or 3 in. from the center of the bar. There is no quenching or special treating of the welds, it being required only that they be allowed to remain in the jig until practically cool; a matter of about 45 min.



Typical Rebuilt Bars as Applied in the Track

In view of the measurements to which the bars are built up, the reclaimed bars should have a relatively snug fit to the worn rails to which they are applied, with uniform bearing contact between the bar heads and the rail head fishing surfaces. While this condition is obtained quite generally, there are many cases where the bearing is limited largely to the limits of the weld, and at the ends of the bar where wear was a minimum. Furthermore, since the bar welds are not finished by grinding, the uniformity of bar bearing on the rail head is not always perfect. This condition seems to offer no serious disadvantages.

The general action of the reformed bars on the surface of the track is illustrated in the accompanying chart, in which is pictured graphically the conditions at four joints, before reclaimed angle bars were applied, immediately after reclaimed bars were applied, and approximately five months later.

These graphs indicate that a low condition existed at all four joints prior to removing the worn bars, and also that there was immediate improvement in this situation when the reclaimed bars were applied. On the average, the leaving rails of these joints, directly at their ends, were raised 0.038 in., while the receiving rails, at their extreme ends, were raised an average of 0.054 in., in both cases, slightly above the normal height of the rails back of the joints.

The readings at these same joints five months later, as indicated in the graphs, show that a favorable condition still obtained. While a slight settling of the joints is evident, the measurements show that, with but one exception, the joints are still a trifle high throughout, and are, on the whole, in better condition than they were immediately following the application of the bars.

Building Up Rail Ends

(Continued from page 76)

vious that a certain amount of preparatoy work is necessary if maximum results are to be obtained. Among other things it is considered essential that all bolts be tightened if the old bars are to remain in place. If they are worn, however, new or reformed bars are applied in advance of the welding. It is also considered essential that the joints be brought to surface, the ties spaced, deteriorated joint ties replaced and the track lined. If the expansion is not uniform, the anti-creepers are removed and the expansion is redistributed to bring it as nearly uniform as practicable.

While some of these items may seem to have only a remote bearing on the welding performance, experience has shown that all of them are essential to avoid a false impression, even when careful measurements are taken, as to the extent of the batter that must be corrected.

Some of the welding has been done in cold weather. It seemed important to avoid a quick rise in temperature at the surface of the rail or the application of the new metal to a cold surface. It was decided, therefore, to preheat the rail ends when the atmospheric temperature fell to or below 40 deg. As a result of the better performance where this was done, it is now considered an advantage to preheat the area to be welded, even at higher temperatures. To do this, the contractor employs a specially designed heater which fits over the head of the rail, using a gasoline flame to raise the temperature of the rail end to about 200 deg. F.

The preliminary investigation of rail end welding and the preparation of programs, as well as the inspection of the finished work and the later watch on its performance, have been carried out through co-operation of the inspection and the maintenance departments of the New York Central. The welding was done by the Electric Railweld Sales Corporation, Chicago.

Structures Offer New Field for Arc Welding

A review of the progress made with special reference to the reinforcement and repairing of old bridges

By GILBERT D. FISH*
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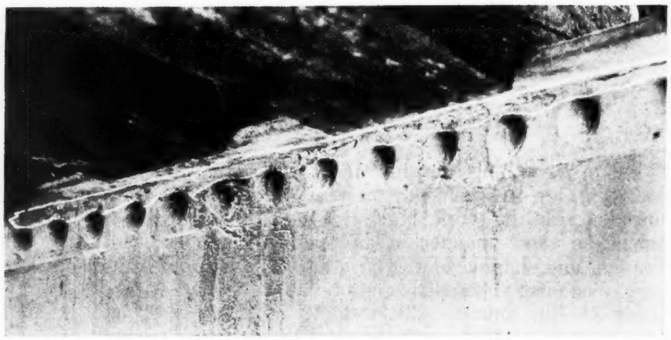
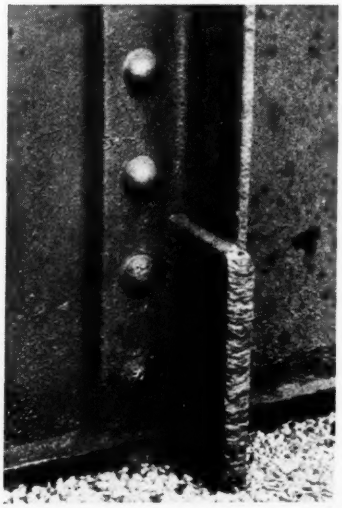


Above—A Job for the Arc-Welder—A Crack in the Heel of the Top Flange Angle of a Stringer



At the Right—How a Corroded Girder Stiffener was Repaired

THE arc welding of structural steel permits far more compact connections than riveting, thus saving connection material and reducing bulk. The absence of rivet holes is an obvious advantage, not only in framed structures but also in plate work, because holes decrease the effective sections of members and are expensive to lay out and punch or drill. Fabrication is simplified by the use of welding instead of riveting, and if structural designing for welding is skillfully performed so as to take full advantage of welding economies, the cost of shop work is appreciably reduced.

In the present state of the art, the shop labor required for welding is about equal to that required to drive or press shop rivets, but in field work the labor charges for welding are distinctly less than for driving rivets of equivalent aggregate strength. In alteration and reinforcement work, the cost-saving advantages of welding are very pronounced, the two chief elements of economy being (1) that even extensive repair or reinforcement can be accomplished in place without temporarily impairing the strength of the structure, and (2) that the serious expense of drilling holes in the field is eliminated.

Welded Structures Require Less Steel

As a matter of design economy, it is very interesting to observe that trusses, plate girders and certain other types of structural elements require considerably less steel if properly designed for welding than if laid out for riveting. Connections in exposed steel structures can be sealed against moisture by arc-welding, effectively preventing the formation of rust and consequent swelling between contact surfaces that are sometimes encountered in parts of riveted structures exposed to severe corrosive conditions. Very small fillet welds are sufficient to seal the cracks where gusset plates and connection angles overlap or are overlapped by main members, and it is a very good though not universal practice to seal all joints by this means after completing the structural welding required for strength.

Very extensive tests have been made on welded joints of various forms under a wide variety of loading conditions, some of these tests having established safe stresses for static or nearly static loads and others having shown the endurance limits under reversed and indefinitely repeated loading. The data thus far accumulated as to the physical properties of arc-welds amply justify the use of the working stresses given by the American Welding Society's Code for Fusion Welding and Gas Cutting in Building Construction for all statically loaded structures, including buildings. Fatigue tests indicate that welds with approximately the same ultimate strength as rolled structural steel have a somewhat lower endurance limit† than rolled structural steel. Consequently the "Specifications for Arc-Welded Connections in Bridges" prepared by the writer provide that in dynamically loaded structures, the maximum stress intensity in any weld, plus one-half the maximum range in stress intensity due to live-load variation, shall not exceed

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†The intensity of stress which may be completely reversed millions of times without causing breakdown in material.

16,000 lb. per sq. in. in cases of direct stress or 10,000 lb. per sq. in. in cases of shear. This provides a safety factor of at least four with respect to the loading which would ultimately break down the weld if the live load were applied and removed enough millions of times.

It is easy to compare these working stresses with those permitted in buildings by the American Welding Society code. For instance, any joint in which the dead-load stress is negligible but in which the live load stress does not reverse, is permitted 10,700 lb. per sq. in. in tension or 6,700 lb. per sq. in. in shear, according to the bridge specification, whereas the building code permits 13,000 lb. per sq. in. in tension or 11,300 lb. per sq. in. in shear, without distinguishing between live and dead load.

Welding Applied to New Structures

To the best of the writer's belief, there are only two completely welded railway spans in this country and one in Europe. The two in the United States are the property of the Westinghouse Electric & Manufacturing Company and were completed in 1928. One is a single track through-truss skew bridge of about 135-ft. span on a siding at Chicopee Falls, Mass., and carries relatively infrequent freight traffic only. The other is a 55-ft. through plate girder span on the Westinghouse Interworks Railway at East Pittsburgh. The European bridge above mentioned is a plate girder span on one of the lines of the Swiss Government railway.

thus resulting in an appreciable saving of metal in the stringers because of a reduction in positive bending moments. It also results in rigidity of the connection of the stringers to the floor beams that is not possible in riveted work. The writer believes that such continuity is desirable, but that in long floor systems it should be interrupted at intervals short enough to avoid trouble by reason of the shortening or lengthening of truss chords in the plane of the floor system.

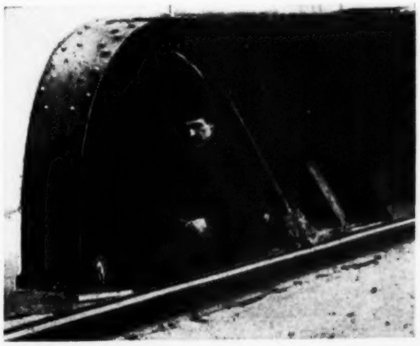
No Angles Required for Plate Girders

Welded plate girders are made exclusively of plate material, no angles being required for either flanges or stiffeners. Stiffeners consist of plates set edgewise to the web and welded to the flanges as well as to the web, and require no filler plates such as are needed for riveted girders where the stiffener angles are not crimped. There need be no holes in a welded girder, and reduction of cross-section area from this source, therefore, does not occur. For a given depth and section modulus, a welded plate girder is appreciably lighter than a riveted one, because its flange areas are more remote from the neutral axis, because no increase in flange area is required to compensate for holes, because plate stiffeners are about half as heavy as angle stiffeners, and because filler plates are not used.

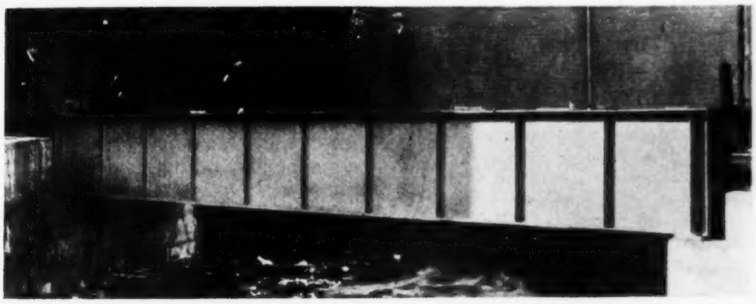
The shop fabrication of welded truss members and plate girders involves somewhat less direct labor and general handling than corresponding riveted members. Field erection of welded structures is definitely less expensive than corresponding work by the riveting method if the welded work is well planned, because field welding costs less than the riveting it replaces.

Welding has been extensively practiced in the alteration of old railway bridges of various kinds. Such work is being done to remedy deterioration caused by rust or corrosion, to restore the original strength of members which have developed cracks in service or of connections which have worked loose, and to increase the carrying capacity of bridges to meet the demands of increased train loads.

As examples of members requiring restoration, there may be mentioned stringers whose webs have cracked



Above—Arc Welder Replacing Corroded Side Plates on a Girder



At the Left—A Welded Plate Girder Span—Note that the Flanges and Stiffeners are Made of Plates Rather than Angles

Trusses designed for arc-welding, whether for bridges or for buildings, and whether light or heavy, require less steel than trusses designed for riveting. The principal sources of weight saving are a reduction in sizes of gusset plates due to the small space required for welds, and the avoidance of the weakening effect of rivet holes. Even though a few holes must be provided for erection bolts, they can usually be located so that they do not establish critical sections in tension members or in gussets.

Welding also affords a ready means of obtaining continuity of the floor stringers through the floor beams, diagonally near the supports or whose top flange angles have cracked along the fillets. Numerous cases of loose stringer connections have been remedied by arc-welding. Floor-beam hangers have frequently been reinforced by means of the arc. Rust and corrosion have shown their worst effects at the edges of channel flanges in latticed truss members and viaduct columns, and in top flange angles of stringers, but all classes of members have apparently been included among those which have been restored, either by welding patch plates over the affected surfaces or by removing parts of old members and replacing them by new parts welded in position. Much of

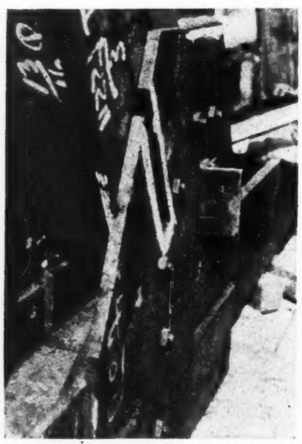
this work is of a character that cannot be duplicated in riveting; in fact, there are conditions of deterioration in steel structures that can be readily corrected by welding, which could not be made good by riveting short of extensive reconstruction.

The practice of reinforcing old steel bridges for the purpose of increasing their load-carrying capacity is well established and has resulted in great economies. The reasons for this are too well understood to require elaboration here, but the application of electric welding to this work has greatly increased the opportunities for strengthening old structures and has also added greatly to the facility and economy with which the work may be done.

Arc welding derives its advantages over riveting in the reinforcement of old structures from the fact that it provides a means for the attachment of new metal without the use of bolts or rivets for which holes must be provided in the structural member to which it must be applied. The benefits which accrue from this are many.

1. It avoids the expense of drilling new rivet holes or of removing old rivets so that new rivets can be driven to attach the new material.

2. It eliminates the detailed measurements of existing members so necessary to insure an accurate fit and the accurate punching of holes in new material to match rivet holes in old members.



Left—Gusset Plate for a Welded Joint in the Lower Chord of a Truss—Note Cut for a Slot Weld and that the Plate is Smaller than Would be Required for a Riveted Connection

Right—Where Arc Welding Proved Especially Valuable. Wear at the Contact of the Bearing Stiffeners on the Bottom Flange Angles Produced a Condition that Would Have Been Almost Impossible of Correction by any Riveted Repair Work

3. It obviates the temporary weakening of members sometimes entailed by the removing rivets or drilling new holes, and thus avoids delays to train service by reason of slow orders or temporary interruptions of traffic. This makes it possible to carry on reinforcing work of a character that would not be attempted by riveting, because of the expensive dismantling or false-work that would be required.

4. It permits effective and economical application of material to old members in positions that would absolutely preclude the attachment of material by means of rivets.

5. It permits of the reinforcement of inadequate riveting in locations where additional rivets cannot be driven, or at a fraction of the expense that would be incurred in removing old rivets, reaming out holes and driving larger rivets.

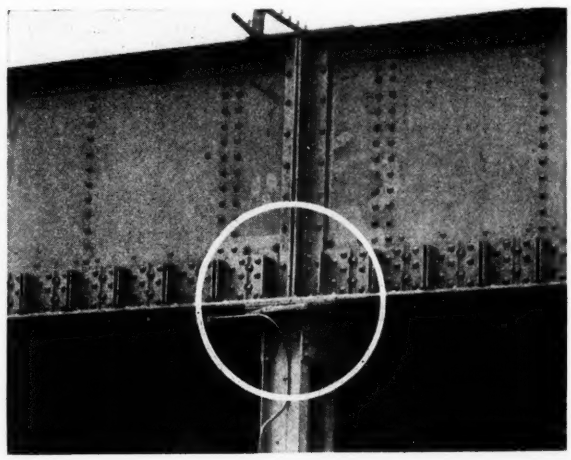
6. The welding necessary to develop a given amount of strength requires fewer hours of labor than the driving of rivets having the same aggregate strength.

In emergency cases, a bridge may be reinforced by welding with minimum preparation and delay; this may permit restoration of traffic hours or even days earlier than would be possible without welding. Some reinforcing operations have been performed by welding which would have been impossible by any other means, as for example welding the main plates of lift-bridge sheaves to the hubs to overcome permanently the loosening resulting from wear.

Signal bridges generally include trusses, posts, knee braces and sway bracing, and as a rule are built up mainly of angles with batten plates and lacing bars. By lapping the chord and web angles and welding them, it is possible to save a considerable amount of steel because much less overlapping space is required than for riveted connections. Less connection material is required, the design as a whole is more efficient and the workmanship is simplified. By means of jigs, it is possible to fabricate a group of identical welded trusses with great efficiency and substantial cost savings as compared with riveted fabrications. Trussed or latticed members belong to a class of assemblies which bring out the economies of welding to a marked degree.

Plate assemblies offer some of the best opportunities to save expense by substituting welding for riveting. For different classes of containers, different features of welding offer advantages. For any vessel designed to hold liquids or gas, the permanent tightness of good welded joints is the outstanding feature, not only in regard to low maintenance cost but also in the cheapness with which tight joints are made in the first place. There is, of course, no caulking, and there is no maintenance expense except for painting or otherwise protecting steel against deterioration. In containers like water tanks which are subject to considerable hydrostatic pressure, the elimination of rivet holes avoids loss of effective section and permits the use of thinner plates.

There are many other railway structures involving the



use of steel, in which arc-welding may be employed to advantage. These include stations, office buildings, shops, enginehouses, coaling stations, coal and ore docks, crane runways, etc. There has been more welded construction in the building field than in any other, and a wealth of information is available on this subject.

Controversial Topics

The foregoing outline of arc-welding in railway structural work has described the utility of the process and its chief advantages over riveting, without discussing dissenting views or mental reservations entertained by some railway engineers who have given serious thought to the subject. The article up to this point having been reviewed by several engineers of broad experience in railway bridge work, some debatable questions have been raised as likely obstacles to the immediate acceptance of welding for some of the applications recommended, particularly new bridge construction. As the ultimate disposal of these questions will depend on experience, rather than on any limited series of crucial tests, the answers

herewith offered can do no more than show general conclusions which appear to be justified by experience.

The most general question, and likewise the most obvious one, is the degree to which the quality of welding can be safeguarded by supervision of the operation and by inspection. There is undoubtedly a widely held belief that inspection of welds is more indefinite in results than inspection of rivets. Without wishing to belittle the importance of scrupulous care in training welders and in supervising and inspecting their work, the writer expresses the opinion that welding, under proper control, is at least as uniform and dependable as the best riveted work. This view is shared by others who have had intimate experience in supervising welded bridge and building construction. The report of the Structural Welding Committee of the American Bureau of Welding, published in 1931 by the American Welding Society, throws a great deal of light on the degree of dispersion in the numerical strength values of welds made by many different operators who passed a certain reasonable series of qualification requirements.

What Careful Inspection Shows

A fillet weld, such as is used for nearly all structural applications, has an exposed face and two exposed edges. Examination of a fillet weld by a trained inspector usually discloses any serious defect, such as porosity, burned metal, lack of fusion or slag inclusions. The surface and the edges generally reveal such faults, if present in more than slight degree, even though the fused contact faces and the interior of the weld are invisible. More information as to the quality of a weld is obtainable by inspection of the finished product than can be deduced as to the soundness of a rivet by any non-destructive examination of it. The safety of properly supervised welding depends on the fact that any deviation by a trained welder from standard manipulation, if sufficient to cause material defects, affects the appearance of his work enough to attract the notice of a skilled inspector.

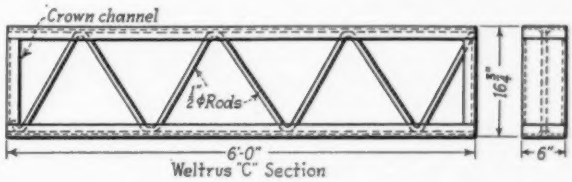
As to Details of Connections

Details of design are, of course, exceedingly important, not only as affecting safety but also with respect to economy. Generally, connection details resembling those used for riveting are possible but not economical in welded construction. The question is raised as to whether welded joint details for use in bridges have been developed and used sufficiently to afford assurance against the development of trouble in service. Engineers raising this question refer to the evolution of riveted bridges, during which some types of joints were found to be defective in design and required repairs to bridges which were otherwise in good condition. Of course, much remains to be learned about welded connections in bridge service. On the other hand, structural engineering knowledge has advanced greatly since the early days of riveted bridges, and laboratory testing of welded joints has been more thorough and more comprehensive than the testing done prior to the design of the old riveted spans. It seems reasonable to suppose that less practical experience will be needed to rid welded construction of unsatisfactory design details, than has been required in the development of riveted bridges. Very reliable forms have been worked out for gusseted joints, chord splices, bearing pedestals, knee braces, sway bracing and lateral bracing connections, stringer and floor beam connections, plate girder sections, girder splices, web stiffeners, and most other details required in bridge construction.

Truscon Announces New Design of Highway Crossing

A NEW crossing, known as the Truscon Weltrus highway crossing, which is an adaptation of the Weltrus pole construction, is being introduced by the Truscon Steel Company, Youngstown, Ohio. In this adaptation, a section of a Weltrus pole is fitted at the ends with crown channel sections. These channels, together with the center reinforcing bar and the sides of the pole section are pressure-welded into a single unit, which, when filled with concrete, is said to form a crossing plank of great strength.

In effect, the Weltrus sections are steel forms which protect all four sides of the concrete and provide complete armor for all corners, thus anchoring the concrete in the armor. It is said that since the corners are fully protected, they do not chip in handling or under the impact of traffic.



Details of a Typical Weltrus Section

Standard Weltrus sections are 16¾ in. by 6 in. by 6 ft., but can be made in any length and in widths up to 21¾ in. They can be secured in heights of from 4 in. to 7 in. in increments of 1 in. Insulation blocks of creosoted oak or asphalt are provided, with ribs that fit into the sides of the sections, thus insuring that they will remain in place.

End sections are designed with sloping plates welded to the sections to protect the concrete and crossing from dragging parts. As an alternate, all-steel end plates are furnished, if desired. To facilitate unloading from cars or other handling, each plank is provided at the ends with lifting holes for the insertion of bolts attached to a chain or for lifting hooks. It is said that lining bars or other track tools can be used freely in installing or removing the planks, without danger of causing damage.

An Installation of the Weltrus Crossing Units

The shipping weight of a standard unit is 104 lb. When filled with concrete, which can be done at destination, this weight is increased to approximately 700 lb. The individual planks are, therefore, heavy enough to stay in place without special fastenings, but can be handled by four men. It is claimed that a complete crossing can be installed or removed by a section gang of four men without the assistance of other skilled labor, that ordinary track maintenance can be performed without interruption to traffic or the removal of all of the crossing sections and that standard units are adapted for use on curves up to 5 deg.

Extending the Life of Rail

(Continued from page 67)

nominal increase in the cost, since the work is usually done by this gang when handling other work in the vicinity.

As has been stated, the service life of the rail on the Illinois Central has been extended from 3 to 8 years by welding. This extension of life has depended, however, on several factors, chief among which are the amount of traffic passing over the track, the weight of the rail and its condition when the welding was done. It has been demonstrated that the increase in life for the lighter sections is at least three years and that this is sufficient to more than offset the cost of reconditioning. As the weight of the rail increases, the differential between cost and savings becomes greater, while with comparable traffic the service life, so far as this depends on batter, is correspondingly increased.

While it is not the practice of this road to include heat treating as a part of the welding process, there has been a marked increase in the hardness of the welded joints as compared with that of the normal rail steel. The Brinnell hardness of the normal rail metal after it has been subjected to the cold-rolling action of the car and locomotive wheels, ranges from 260 to 265. By way of comparison, hardness tests made with a rebound scleroscope on welds immediately after grinding and reduced to the Brinnell scale have shown a hardness ranging from 325 to 350, with only a minor number falling below the lower reading. Similar tests made about one year after the welding was done have shown increases extending up to 400 in the hardness of the welded metal of the rail ends.

Batter Is Definitely Retarded

To determine the rate of batter, the performance of the joints has been watched with some care. It has been found that, with the exception of occasional joints which did not receive the proper workmanship, batter has been definitely retarded in all cases and practically eliminated in many of them. Similar investigations have been made to determine whether secondary batter is occurring as a result of the increased hardness of the added metal or because of other features of the process. To date, however, no secondary batter has been found in recent work, which can be traced to any of these causes, although in the early years, when the finishing was not so well done, some secondary batter did develop.

Owing to the length of time that this road has been rebuilding its rail ends, it has had an opportunity to determine the feasibility of rewelding joints when they have again battered to the defined limit. Early tests demonstrated that there were no objectionable features in this practice and it is now done as a regular operation, provided the general condition of the rail warrants, thus extending the life of the rail still further beyond that already obtained.

Present practices in welding rails have developed out of an experience of more than 12 years. In addition, the welding operators as well as the maintenance officers have had available the advice of the Oxweld Railroad Service Company and the advantage of its knowledge of current developments in welding methods and equipment. The programs are carried out by the division engineers and supervisors on the sections of the system involved, under the general direction of L. H. Bond, engineer maintenance of way, and M. M. Backus, assistant engineer maintenance of way.

Repairing Manganese Trackwork

(Continued from page 71)

for a large part of the repair and building-up work, but where large amounts of metal must be deposited, a ¼-in. rod is used with equally good results and has the advantage of speeding up the application of the metal.

Ordinarily the welds are made in courses of parallel lines of beads, with the direction of the beads in each course at an angle of at least 30 deg. with that of the lines of beads in the course either directly above or below. Furthermore, the length of bead laid down in any continuous operation is usually limited to four to six inches, it having been found that shrinkage cracks develop in longer beads during cooling. Also, when continuous beads 12 in. or more in length are laid down on the top surface of a frog, it has been found that the shrinkage force as the beads cool is actually sufficient to pull the entire frog casting out of surface, causing it to curve upward at the ends.

In the grinding operations, it is only necessary to manipulate the grinder in such manner as to produce a uniformly smooth surface in the plane of the adjacent original metal. This is done with little more difficulty than shaping a built-up rail end, and, therefore, is not one of the important elements which have retarded the successful development of manganese welding.

Small Costs, Large Savings

All of the repair of manganese trackwork on the Lehigh Valley in the past has been done by one welder, assisted at the shop by a man who did the preliminary and final grinding, and in the field by a helper who assisted in both welding and grinding operations. To date, 350 turnout frogs and 60 crossing frogs have been built up or repaired, the time required to repair either type ranging from two to eight hours.

The periodic touching up or resurfacing of frogs in the field costs about $15 in the case of a turnout frog, and approximately $50 in the case of all points of a single-track crossing. Repairs made at the frog shop are slightly lower in cost than those made in the field, but they involve the added expense of removing the unit from the track and shipping it to the shop. It is in view of this latter expense that it is planned that in the future just as much of the work as possible will be done in the field. Even if it becomes necessary to remove a frog from the track for repairs, it is expected that this repair work will be done on nearby available ground by the subdivision welding force to avoid the extra handling and shipping costs involved.

What the Lehigh Valley has already saved through its repair of manganese trackwork, and the possibilities for savings in the future are best appreciated when it is realized that worn crossings, costing from $1,400 to $1,600 each, can be restored to their original state of serviceability with an average expenditure of approximately $50, and that worn turnout frogs of heavy section, costing from $170 to $320 each, can be restored through welding at an average cost of approximately $15. Added to this large saving is the rather indeterminate saving effected through reduced wheel damage at crossings and turnouts, and the quieter, better riding track conditions which will prevail.

All of the work on the Lehigh Valley in connection with the welding of manganese trackwork has been carried forward under the direction of G. A. Phillips, chief engineer maintenance, and under the direct supervision of C. A. Miller, supervisor of frog shop and roadway tools.

Welded Joints Improve Tunnel Track Conditions

Work done by Central of Georgia in 1930 stands up well and results in largely reduced maintenance expense

CONFRONTED with the problem of maintaining good track economically within tunnels, the Central of Georgia, in 1930, installed track with welded rail joints in two of its tunnels. In this work, a total of 192 joint welds were made, and in the longer of the tunnels the rails were made continuous throughout a distance of about 2,450 ft. Up to the present time, experience with the installations, as reflected both in the condition of the track and in reduced maintenance costs, has been entirely successful, and it has been demonstrated to the satisfaction of the road that the welding together of the rails in tunnels is practical.


Strings of Welded Rails Ready to Be Dragged Into Tunnel

Track Maintenance Excessive in Tunnels

The tunnels in which the rail welding was done extend through Coosa and Oak mountains, about 21 miles southeast of Birmingham, on the line between Columbus, Ga., and Birmingham, Ala. Both of the tunnels are single-track, the Coosa Mountain tunnel being 2,431 ft. long and the Oak Mountain tunnel 1,198 ft. long.

Prior to the welding of the rail joints, track maintenance within the tunnels was a serious problem. With limited overhead and side clearances, and solid rock floors in both tunnels, only a small amount of ballast is possible under the ties, and this, coupled with the constant dampness and the severe corrosive action of gases on the angle bars and track bolts, resulted in low joints and rail batter almost regardless of the efforts of the track forces. As a consequence, the service life of the rails and fastenings within the tunnels was limited to about three years, and riding conditions were never comparable with those on track in the open.

The extent of the damage caused by corrosion is shown by studies made prior to the rail welding work to determine the actual loss in the weight of joint bars. In making these studies, two pairs of new, untreated, 90-lb. angle bars, and two pairs of new, chromium-plated bars, the latter equipped with plated bolts and nut locks, were applied at a location within the Coosa Mountain tunnel where poor drainage and corrosive action reflected the worst condition. After 31 months of service in the track, the untreated bars showed a loss in weight of 4 lb. per pair, and even the chromium-treated bars showed a loss in weight of 1 lb. 9 oz. per pair.

To help offset these conditions, the Central of Georgia undertook in 1930, the welding together of the rails to be laid in the tunnels. In this work, in which the old 90-lb. rails were renewed with rails of similar section, the rails were welded together continuously throughout the length of the tunnels, with no expansion joints, except at the ends. Experience and tests showed a relatively small range of temperature within the tunnels, around 53 deg. F., so that no trouble was anticipated with expansion and contraction of the long rails. One-quarter inch of expansion space was allowed in the first joint at each end of the long rails, but this has proved unnecessary since there has been no perceptible movement of the rails.

As a special precaution, all of the welded joints were fitted with second-hand 100 per cent, four-hole joint bars, and the joints were fully bolted as in standard construction outside the tunnels. This practice increased the total cost of the completed joints, but made it possible to derive the value of the continuously welded rails without any concern for the safety of the track structure.

In the welding work, the rails were joined into 429-ft. lengths outside the tunnels, and were later pulled into position in the tunnels in these lengths where they were joined together by welds into continuous rails. All of the welding was done by the oxy-acetylene method, using acetylene gas and Linde oxygen delivered to the work in the usual type of steel containers. No. 1 Oxweld rods were used for the rail base and the web and parts of the ball, while Oxweld "MW" rods were used finishing off the top or running surface. The work was done in the open during July and August, and the installation in the tunnels was made during the latter part of August.

In order to carry out the welding work expeditiously, it was done on rail stands made of sawed crossties, which were located along tangent track, as close to the portals of the tunnels as possible. The ties of the rail stand were leveled up on blocking, with five ties beneath each 39-ft. rail, and a sufficient number in line to accommodate the 11 rails to be joined in each string.

The new rails were unloaded from cars on the main track by means of a rail loader and were placed directly across the track from the rail stands. From this position they were placed on the stands, end to end, by the section forces, using rail tongs.

Just prior to lining up the rails for welding, which was done by a track foreman, the ends of the abutting rails were raised slightly and supported on tie plates or second-hand guard rail plates, this being done to overcome the effect of the greater shrinkage which takes place during the cooling of the greater amount of weld metal applied in the head of the rail. Final lining of the rails, at the joints, was done by the welders with a steel straight edge.

The only work on the rails prior to actually welding them together was what was called "V"ing of the rail

ends. In this work, which was done with a cutting torch, the web and the flanges of the rail base were beveled off so that there would be a distinct "V" in the junctions between the webs and the base flanges of abutting rails. The rail heads, on the other hand, were beveled downward from a point about 1/4 in. back from the end of the rail, except for a rib left in the center of the head to facilitate the starting of the head weld.

Actual welding operations were carried out along lines recommended by the Oxweld Company. Welding was started at the center of the base, directly at the base of the web, with the rails tight together in order that the temperature of both would be kept as nearly the same as possible during the welding operations. From the center of the base the welds were extended outward on each side, completing the base weld, and were then carried up the web and halfway up the head. Using a different rod, the head weld was then made, the top surface being completed last.

In this latter work at the running surface of the rail, the new weld metal was constantly peened, as applied, with a 2½-lb. machinist's hammer. The final smoothing and finishing of the top of the head weld was done by holding a three-pound flatter on the weld surface and striking it with an eight-pound hand hammer. After completing a weld, all excess metal on the bottom of the head and on the web and base was removed with a torch to permit a snug fit of the angle bars.

All of the welding was done by two crews, each consisting of an experienced welder and an assistant. Throughout the work, each crew completed an average of 3.29 welds in an eight-hour day. Welding operations were carried out with the oxygen at a pressure of 45-lb. and the acetylene between 5 and 6 lb. pressure. the pressure of the acetylene varying within specified limits to secure the most favorable blue-tip flame at the nozzle of the welding torch. The average amount of material used in making each weld was 2¼ lb. of steel, 80 cu. ft. of oxygen and 70 cu ft. of acetylene.

Details of Laying Long Rails

After all of the welds had been completed in several strings of rails, the strings were lined to the center of the main track, one at a time, with bars, over skids which had been provided between the rail welding stand and the track. Immediately following this, each string was dragged into the tunnel by a locomotive, where, at the proper point, it was lined outside the track, in the clear, on timber skids placed over the side ditches and level with the track. While in this position, the angle bars were applied to each welded joint and the bolts tightened. Relay bars and second-hand bolts were used.

After the last of the long welded sections had been pulled into the tunnel and had been allowed to stand 24 hours to assume the normal temperature within the tunnel, rail laying began. This was handled by a force of 20 men, made up of an extra gang of 15 men and a regular section gang of 5 men. Using rail tongs, no difficulty was experienced in moving the long rails lengths longitudinally the small amount necessary to effect joint closures.

Prior to the actual rail renewal, the track had been overhauled carefully, making such tie and tie plate renewals as were necessary and correcting all irregularities in line and surface, so that the rail renewal itself involved only the substitution of the new rail for the old. After spikes had been pulled, the old rails were lined toward the center of the track, the spike holes were plugged, and the new long rails were then lined into position and spiked.

Immediately following the completion of the rail laying, the track was again given a careful surfacing and, at the same time, the joints between the 429-ft. rail sections were welded under traffic, making the rails continuous throughout the tunnels. This latter welding was done in a manner practically similar to that used out in the open on the rail stands, but because of traffic and certain inconveniences attendant to the welding in the track, the cost of this work was slightly higher than the welding in the open.

Concerned about excessive corrosion of the new rails and the rail fastenings, which it was felt would limit their effective service life, all of the exposed steel of the track structure, except the running surface of the rail head, was painted with a light preservative coating of Thuban Compound oil immediately following the rail renewal work. Several months later, the rail and fastenings were given a second light coating of the same oil.

Track Conditions Greatly Improved

Frequent inspection of the joint welds in the track of both tunnels shows that the welds made were sound and that the welding was highly justifiable and practicable. Furthermore, track conditions within the tunnels have been greatly improved and the excessive and expensive track and joint maintenance necessary formerly are a thing of the past. No trouble has been experienced with rail expansion and contraction.

The welding work was carried out under the general direction of C. E. Weaver, assistant general manager and chief engineer, and under the supervision of W. D. Rhoads, division engineer of the Columbus division, to whom we are indebted for the information presented in this article.

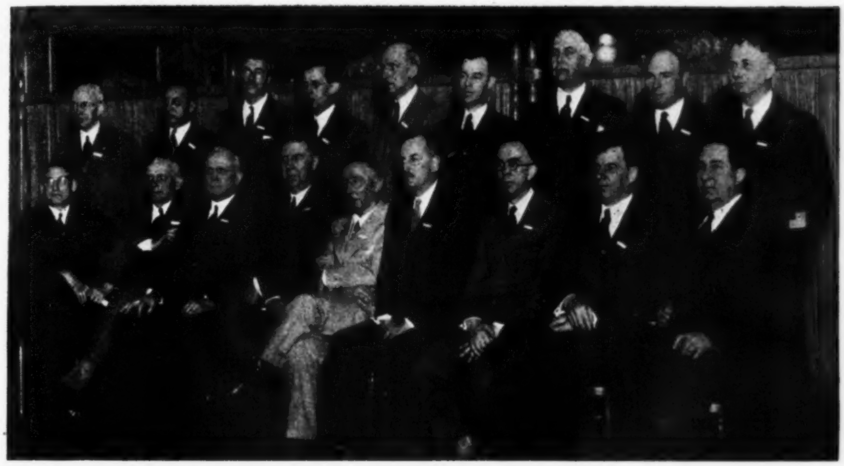
Pennsylvania Arc-Welds Crossings

(Continued from page 73)

The crew includes two men, a welder and a helper who does the grinding, and, in some cases, a watchman to warn the other two to clear trains. The Pennsylvania, however, provides the watchman. The contract provides that the work shall be so conducted as to entail no interference with train movements. It is essential, of course, that any crossing that has been restored by welding should be given adequate overhauling with respect to the tightening of bolts or the replacing of missing, worn or overstressed bolts. This work, however, is normally done by railway forces along with surfacing and other regular maintenance operations.

The Pennsylvania is convinced of the economies of arc-welding as applied to manganese steel crossings. True, there have been failures, but these have been ascribed to difficulties encountered in the reclamation of crossings presenting rather severe defects. The situation with respect to failures has greatly improved with increased knowledge of the problems and difficulties imposed and with the realization that better results and greater economy are secured if the work is programmed so that the crossings receive attention before serious defects develop, in other words, if the arc-welding of crossings is approached as a matter of maintenance rather than reclamation.

We are indebted for the above information to Porter Allen, chief engineer, maintenance of way of the Western Region of the Pennsylvania, and members of his staff.



Fifteen of the 18 Living Past Presidents Were in Attendance at the Meeting. Seated, left to right, Walter Buehler (1908-9-10); George E. Rex (1914); Carl G. Crawford (1916); John Foley (1917); J. B. Card (1919); A. R. Joyce (1920); C. M. Taylor (1921); W. H. Grady (1922); E. J. Stocking (1924). Standing, left to right, C. F. Ford (1926); O. C. Steinmayer (1927); H. R. Condon (1928); H. E. Horrocks (1929); C. C. Cook (1930); John S. Penney (1931); Elmer T. Howson, President; R. S. Belcher, First Vice-President, S. R. Church, Second Vice-President

Discuss Uses of Treated Wood

Twenty-ninth annual convention of the American Wood-Preservers' Association held at Chicago on January 24-26

RAILWAY ENGINEERING and maintenance of way officers were prominently identified among the more than 300 members and guests who attended the twenty-ninth annual convention of the American Wood-Preservers' Association, which was held on January 24-26, at the Hotel Sherman, Chicago. There was a good reason for this, as four of the seven papers and reports presented at the "Users Day" session were concerned exclusively with the applicability and service rendered by treated wood in railway tracks and structures, while most of the matter under discussion at the other sessions was of almost equally direct interest to railway men. Among railway officers who had a part in the program were D. C. Curtis, chief purchasing officer of the Chicago, Milwaukee, St. Paul & Pacific, who presented a paper on the Economic Selection, Treatment and Use of Crossties; Earl Stimson, chief engineer maintenance of the Baltimore & Ohio, who prepared a paper on the Economic Value of Treated Timber Now and in the Future; and Colonel H. Austill, bridge engineer, Mobile & Ohio, who read a paper on Service Records of Timber Bridges. These papers will be abstracted in later issues.

The presiding officer throughout the convention was President Elmer T. Howson, editor of *Railway Engineering and Maintenance,* who was succeeded at the close of the convention by R. S. Belcher, manager of treating plants, Atchison, Topeka & Santa Fe, Topeka, Kan. The other officers elected were: First vice-president, S. R. Church, consulting engineer, New York; second vice-president, F. D. Mattos, manager treating plants, Southern Pacific, San Francisco, Cal.; secretary-treasurer, H. L. Dawson, Washington, D. C. (re-elected); members of Executive committee, H. R. Duncan, superintendent timber preservation, Chicago, Burlington & Quincy, Galesburg, Ill., and W. P. Conyers, Jr., treasurer, Taylor-Colquitt Company, Spartansburg, S. C. Houston, Texas, was selected as the meeting place for the next convention.

In his address at the opening of the convention, President Howson reviewed the work of the association during the past year and the current trends in the wood-preserving industry, pointing to the need for the continuation of active educational work for the attainment of a maximum application of preservative processes. Touching on the influence of the current economic situation, he noted that the wood-preserving industry, in common with other industries, has suffered a reduction in volume during each of the last three years until its output during 1932 was probably less than half of that of 1929 and was smaller than for any year since 1922. In this respect it is more sorely pressed than some more fortunate than most other industries, especially when one considers that the normal trend of the industry is to reduce the demands for its product as the very excellence of the work postpones replacement. Take railway crossties as an illustration. It is not many years since the normal requirements exceeded 100,000,000 ties annually, yet by 1929 they had fallen to 75,000,000 and will ultimately find their level, with universal treatment, at perhaps 60,000,000 to 65,000,000. So it will be with other products—poles, piling, bridge timbers, etc., as treatment becomes universal. The railway industry, however, offers large opportunities for the more extensive use of treated timber that have not yet been developed, in spite of the fact that the industry has demonstrated its merit most fully within the railway field.

Touching on the trend of the times, he declared that there are now definite factors indicating that the long-heralded recovery is now under way. In support of this, he cited the trend of car loadings, which are reviewed in detail in the letter on page 58 of this issue.

Review Service Performance

In addition to reports of inspections of ties in test tracks on nine railways, the Committee on Tie Service Records, of which W. R. Goodwin, engineer of wood preservation, Minneapolis, St. Paul & Sault Ste. Marie, was chairman, presented its annual report on crosstie renewals per mile of track maintained, this table being extended to include the data for 1931, and figures for

the Boston & Maine, in addition to those for the 26 railways covered in previous tables. As a result, the table, which is reproduced in abstract herewith, embraces tie renewals on 200,442 miles of tracks. This table also shows the practice of 23 of these railways with

Road	Renewals per Mile of Track 1931	5 Year Aver.	Adzing and Boring Yes or No	When Started	Length
A. T. & S. F.	111	150	Yes	1912	8 ft.
B. & O.	46	140	No	....	8½ ft.
B. & M.	157	253	......	....	....
C. R. R. of N. J.	81	79	Yes	1912	8½ ft.
C. & O.	138	194	Yes	1925	8½ ft.
C. B. & Q.	134	158	......	....	....
C. & E. I.	98	119	No	....	8 ft.
C. I. & L.	147	129	No	....	8 ft.
C. M. St. P. & P.	186	266	......	....	....
C. R. I. & P.	103	140	Yes	....	8 ft.
C. C. C. & St. L.	79	93	Yes	1925	8½ ft. & 8 ft.
D. L. & W.	70	82	Yes	1911	8½ ft.
Gt. Northern	168	198	Yes	1925	8½ ft.
I. C.	184	191	Yes	1924	8½ ft. & 8 ft.
K. C. S.	147	148	Yes	1926	8 ft.
L. V.	53	66	Yes	1929	8½ ft.
Mich. Cent.	78	108	Yes	....	8½ ft.
M. St. P. & S. S. M.	173	234	Yes	1925	8 ft.
M-K-T.	94	194	Yes	1926	8 ft.
N. Y. C. (East).	96	130	Yes	....	8½ ft.
N. Y. C. (West).	57	75	Yes	1926	8½ ft.
N. P.	108	133	Yes	1911	8½ ft.
Penna.	75	139	No	....	8½ ft.
Reading.	96	128	Yes	1912	8½ ft.
S. P. (Atl. Sys.)	129	191	Yes	1924	8 ft.
S. P. (Pac. Sys.)	138	188	......	....	....
U. P.	106	156	Yes	1928	8 ft.

respect to adzing and boring and the standard lengths of ties.

The committees on Marine Piling Service Records and on the International Termite Exposure Test presented progress reports but offered no conclusions. Service records were also presented by the Committee on Pole Service Records, which also offered a set of detailed suggestions for the care of treated poles covering handling, storage, distribution and installation.

The subject of service records of wood bridges has been organized by the Committee on Bridge and Structural Timber, of which G. A. Haggander, bridge engineer, Chicago, Burlington & Quincy, is chairman, on a basis where it will soon yield a fund of service data equally as comprehensive as those now available on the life of ties. The committee has compiled complete information on the materials and construction details of 13 pile trestles and 3 other structures on which service reports will be presented periodically, although a considerable proportion of these structures are so new that it will be several years before life data will be forthcoming.

Discuss Creosote

The report of the Committee on Preservatives was devoted in part to a comparison of different methods of creosote analysis and also to a statement of the progress being made in the study of heavy or high-residue creosotes, which has consisted to date largely of determinations of loss by evaporation under accelerated artificial weathering tests or ordinary actual weathering. Progress was reported also on the committee's study of the requirements of creosote and petroleum for mixture treatments.

A considerable part of one session was devoted to a discussion of the toxicity of creosote and of mixtures of creosote with other materials, two papers dealing with this general subject being presented. The toxicity of creosote-petroleum and creosote-coal tar mixtures was discussed in a paper by Henry Schmitz, chief and professor of forestry, University of Minnesota, whose conclusion, based on a series of carefully controlled tests, is that the toxicity of creosote-petroleum mixtures is invariably decreased more than would be suggested by the degree of solution. In other words, in a 50-50 mixture, the toxicity, according to his studies, is less than half the toxicity of the creosote used. On the other hand, he showed that in creosote-coal tar mixtures this reduction in toxicity is not experienced, because coal tar is in itself quite toxic. He added, however, that these conclusions should not be taken literally, because in actual preservation other relationships exist which are not duplicated in laboratory tests.

In a second paper on this general subject, Dr. Hermann Von Schrenk, consulting timber engineer, St. Louis, Mo., discussed toxicity tests from a broader standpoint than that of the laboratory. While he commended Dr. Schmitz for the work he has done and considers that he has made a valuable contribution to our present knowledge of this subject, it was his view that, in the present state of the development of this branch of research, toxicity tests are of value only as a means of determining whether substances are toxic. In other words, a toxic substance will continue to be toxic when injected into wood, while a non-toxic substance will still be non-toxic when so injected. Up to the present, however, no method has been devised to forecast the degree of toxicity which will be obtained after injection, so that the relative values of any two preservatives still remain undetermined, except from service results. Dr. Von Schrenk concluded by pointing to the many records of long service that are being obtained from ties protected with mixture treatments. These are the answer to the laboratory, he stated.

Consider Plant Operation

One of the most comprehensive reports presented at the convention was that of the Committee on Plant Operation, which was devoted to the description and use of power equipment. This not only covered a description of locomotive cranes and other hoisting equipment, as well as gasoline and fireless steam locomotives, but gave space to tie-stacking machines, and described in considerable detail such equipment as the adzing, boring and branding machine, the incising machine, tie and timber dappers, framing machines, gaining machines and power drills. The report served as an excellent record of the progress made in the application of power equipment in wood preservation.

Other papers and reports dealing with the more technical side of wood preservation covered such subjects as the Effect of Heating Wet Wood on Its Subsequent Dimensions, by Arthur Koehler, United States Forest Products Laboratory, and another on Experiments with the Boulton Process in the Treatment of Green Southern Pine Poles, by J. D. McLean, also of the Forest Products Laboratory.

E. T. Gowing, assistant to vice-president of the American Creosoting Company, presented a brief report on behalf of the Committee on Diversified Uses of Treated Wood, citing in particular the application of treated timber to scale platform floors. He also reported the further use of creosoted piles in building foundations.

A. W. Armstrong, executive vice-president of the Wood Preserving Corporation, Pittsburgh, Pa., reported for the Committee on Processing of Wood, outlining briefly the progress which the committee has made in the development of co-operative studies of means for increasing the utility of treated wood, including ways of reducing the fire hazard of treated wood.

Discuss Fire Hazard

Three papers and reports relating to the inflammability of wood were presented at the convention. The fire-proofing of wood was covered in a progress report

on experiments conducted by T. R. Truax, C. A. Harrison and R. H. Baechler, at the United States Forest Products Laboratory, which indicates that much progress has been made but that no practical reagent for the fire-proofing of wood has yet been developed. In addition to this paper, another covering investigations conducted at the Forest Products Laboratory of Canada, by J. F. Harkom and J. I. Dore was also presented.

The matter of fire hazard was covered in a report of the Special Committee on the Effect of Treatment on the Inflammability of Wood, of which George E. Herrmann, manager of the Vancouver Creosoting Company, Ltd., was chairman. This report offered evidence and arguments tending to depreciate the hazard of fire in such structures, in part as follows:

Wooden structures designed previous to 15 years or so ago, present a fire hazard that is not present in more recently designed facilities, although fire losses in such have been low. They can be rendered more fire-safe with the expenditure of an inconsiderable sum of money.

The engineering departments of several of the largest North American ports feel that in their recently designed wooden piers, they have reached a degree of fire-safety fully commensurate with economy and providing adequate protection from loss of both life and property.

The fire marshal of a large Pacific Coast district, publicly gives it as his "considered opinion that a recently-built dock (costing over $1,000,000) is one of the best examples of fire-resistive construction for timber docks on this continent." He believes "that the engineers have demonstrated that a timber dock properly constructed and protected is as safe and will give as good service at a much lower cost as any type of dock now in use."

The chief engineer of an important American railway has said, "I believe the unquestioned economy in the use of treated timber far outweighs any question of fire hazard."

Another prominent railway engineer has remarked, "We have not found the fire hazard in creosoted timber trestles to be any greater than that of untreated timber structures and our fire loss is extremely small."

Another engineer has said, "The Illinois Central has been using creosoted timber in water tanks for nine years. We built 30 creosoted tanks in 1917 and 1918, and in 1918 our fire losses in tanks were reduced to $1,287. Since that time, up to September 12, 1924 (about seven years), we have had no losses of tanks from fires, in spite of the fact that we have erected 125 creosoted tanks during that time."

The report also included observations on the uses of treated wood and on the causes of fires, and recommendations covering good practices in fire prevention.

Seasoning After Treatment

When it is practicable, and if considered necessary, creosoted timber may be seasoned after treatment in order that the very light and more volatile oils carrying the lowest flash points may leave the treated timber.

In this connection, however, it is noteworthy that few fires have occurred within six months of the date of preservative treating. Where such has been the case, the causes were easily preventable.

This leads your committee to the thought that perhaps too much stress has been laid on the necessity for after-treatment seasoning. We think it desirable, when practicable, but of insufficient importance to hinder necessary speed of construction, especially when common sense fire-safety measures are employed.

Fire Causes

A brief study of the causes of fires indicates the prominence of the following:

Failure to promptly notify the fire department when a blaze is first discovered. Minutes lost herein account for large losses.

Failure to provide, and have readily accessible, fire fighting equipment, and to properly instruct permanent employees in its use.

Lodgement of lighted cigar or cigarette stubs in crevices or depressions where refuse has collected.

Decayed untreated wood in or about a structure.

Forest or grass fires.

Accumulation of weeds, dead grass or tumble weeds in or around a structure.

Sparks from locomotives, boats, etc.

Hot coals dropped by engines, cranes, tar kettles, rivet heaters (and hot rivets therefrom), or other construction equipment.

Oily waste, garments and other refuse left lying about.

Defective insulation of electric wiring.

Fires in adjacent structures.

Fire-Safety

Fire-preventive measures are too often overlooked, particularly during construction. Many of the precautions intended for the structure during its use can be inaugurated at the commencement of construction. Rubbish, weeds, decayed wood, etc., should early be removed and premises kept free thereof throughout building operations. Open fires should be guarded, and fire-fighting equipment, including sand boxes and water barrels and buckets should be provided in their proximity. Locomotive and other motive equipment crews should be cautioned against cleaning fire boxes, and dropping live coals on or near creosoted timber.

The use of blow torches, which yield a high degree of heat, is dangerous and should be prohibited unless absolutely necessary and then only under strict surveillance. Workmen should be cautioned and instructed regarding fires.

Decay in Buildings

Sand or dry cement can be sprinkled over freshly creosoted or bleeding open deck bridge ties, or structural members, very cheaply.

During the operation of the structure, it is imperative that the practical rules and regulations of the fire-protection authorities be fully carried out. To do so entails no great expenditure of money or supervision.

Weeds and grass beneath creosoted bridges should be cleared away periodically. A weed killer might be used to advantage.

In a paper based largely on a study of building failures as a result of decay, in humid sections of the United States, C. Audry Richards, of the United States Forest Products Laboratory, Madison, Wis., discussed the conditions favoring decay and offered specific suggestions designed to prevent a recurrence of the experiences cited. This discussion of the causes, which is abstracted below, serves to correct some long prevailing misunderstandings.

Much has been written or said about "dry rot" in buildings. Any brown, crumbly rot is so called, but the term is a misnomer. No fungus can grow without water. Wood is the food for the wood-destroying fungi, but they can not use that food unless it contains at least 20 per cent of water (based on the weight of the oven-dry wood). However, the true dry-rot fungi which are responsible for a large amount of decay in buildings are capable of rotting wood that is apparently much drier for they produce water-conducting strands which carry water from some source, usually in the ground, up into buildings where the wood normally would be dry. Moreover, some wood-destroying fungi can remain dormant in dry wood for months or even years and then revive and continue their destructive work as soon as moisture becomes available. In some buildings in the South the heavy condensation that takes place in walls and between sub-floors and top floors seems to supply sufficient water to allow the fungus to continue its activity.

Preventive measures were suggested, as follows:

It is much easier to prevent decay in buildings than it is to eliminate the decay after it is once started. There is only one general rule to remember: Control the moisture content of the wood or, if the conditions of use are such that the moisture content can not be controlled, use wood treated with a suitable preservative.

In the construction of new buildings the following precautions should be taken in order that decay of the buildings might be prevented: (1) Build on a well-drained site; (2) secure well-seasoned lumber from a yard where rot in foundations and lumber piles is not tolerated, rejecting any material that is suspected to contain incipient decay; (3) do not allow the selected material to lie on the ground after it has been delivered on the job; (4) untreated lumber should not be allowed to come in contact with the soil or with foundations or walls which are liable to be damp, and should not be imbedded in concrete or masonry without leaving ventilation around the ends of the timbers; (5) wood flooring should never be laid directly on the soil or on concrete unless it has been chemically preserved; (6) ample ventilation should be provided so that free circulation of air around the wood will keep the wood dry. No general rule as to size and number of ventilators desirable can be given, but they should be large enough and so placed that no dead air pockets will be formed.

What's the Answer?

Have you a question you would like to have someone answer?
What is your answer for any of the questions listed in the box?

To Be Answered in April

1. *Where rail is "tight", what practical measures can be taken to open up the expansion gaps?*
2. *Under what conditions is it economical to give preservative treatment to second-hand bridge timbers?*
3. *To what extent should the section forces clean and shape side ditches through cuts in the spring? Should this be done as a special job or in connection with other work?*
4. *Where a well screen becomes clogged with sand, what measures, if any, can be employed to overcome the trouble?*
5. *Is it possible to start surfacing track too early in the spring? Why? If so, what are the effects?*
6. *What is the minimum size of downspouts that should be permitted on station buildings? Why?*
7. *When removing foul ballast and clay from a heaved spot, how far each way and how deep should this be done? What material is most suitable for back filling to prevent future heaving?*
8. *Where a bridge pier or abutment requires renewal or extensive repairs, is it practical or economical to support the spans on untreated falsework and delay the repairs until full service life has been obtained from the timber? Why? What difficulties are involved?*

Handling Ties on a Trailer

When handling ties on a trailer, should they be loaded lengthwise or across the track? Why **?**

Loading Across the Track Most Practicable

By L. D. GARDNER
Extra Gang Foreman, St. Louis-San Francisco, Winfield, Ala.

For quick unloading, the laying of the ties lengthwise on a trailer is satisfactory, but the more practical way is to load them across the track. Nearly all ties are now adzed and bored at treating plants and have a line end which should go on the line side of the track. It saves time when unloading from a trailer to turn the ties the way they are to go into the track, and this can best be done by loading them across the track. By following this practice the ties will be unloaded in such a manner as not to require extra handling when inserting them and the total amount of labor involved will be reduced.

Disapproves Loading Lengthwise

By R. ROSSI
Yard Foreman, Alton, Glenn, Ill.

Loading ties on a trailer lengthwise with the track is not good practice, since they are quite likely to roll off when the trailer is in motion, and may cause derailment of the cars and personal injury to the men. During my first few years of service, I followed this practice but after several near accidents, I changed my method. Owing to these experiences, I now load them alternately across and lengthwise of the track, placing 10 ties in each of the first two layers and 9 in the succeeding layers. The top layer should be laid lengthwise and have only 8 ties. This system will eliminate any danger of the ties falling off while the trailer is in motion.

Depends on Where the Unloading Is Done

By W. E. TILLETT
Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

If ties are to be handled for a considerable distance on a trailer, they should be stacked in layers alternately with and across the track, since when loaded in this manner they are less likely to fall off. If the distribution is to begin only a short distance from the unloading point, however, they can be loaded lengthwise, particularly on multiple track lines where they must be placed between and parallel to the tracks. On the other hand, if they are to be unloaded outside of the track or tracks, it is better to load them crosswise. In any event, the foreman, who is familiar with the conditions, should be capable of determining the safest and most convenient method of loading.

Depends on Distance and Number of Ties

By W. R. GARRETT
Yard Foreman, Chicago, Burlington & Quincy, Pacific Junction, Iowa

It is scarcely possible to give a categorical answer to this question, since the method to be used will depend in large measure on the number of ties which must be handled and the distance they are to be hauled. When handling only a few ties, particularly in emergencies, they should be loaded across the track as they can be pulled off the trailer and placed at right angles to the track without extra handling. If a full load of ties is to

be hauled for a considerable distance, they should be loaded crib fashion, with the ends projecting on all sides to prevent any of them from falling to the sides or rear; ties seldom fall to the front of a trailer in motion. When loaded wholly lengthwise or crosswise, only a limited number of ties can be handled safely, particularly for any distance.

Loading Across Track Reduces Labor

By Engineer Maintenance of Way

Ties handled on a trailer for distribution should be loaded across the track. The advantage of this method lies in the reduced amount of labor and, therefore, of the cost involved in loading and unloading, including the fact that when unloaded they fall more nearly in the correct position for insertion in the track than would be the case if thrown off parallel to the rail.

Less Danger if Loaded Lengthwise

By W. R. CRANE

Motor Car Operator, Missouri Pacific, Osawatomie, Kan.

Ties should be loaded on trailers lengthwise of the track. With this method of loading, one man can walk in front of and one man to the rear of the car to unload. If they are loaded crosswise, it is necessary for one man to cross to the rear of the car and back again for every tie unloaded, which definitely slows down the work. If they are loaded lengthwise, any tie which might roll off of the car while it is in motion will fall in the clear instead of across the track, and probably ahead of the trailer, as may occur when loaded crosswise.

[Replies to this question were also received from H. E. Herrington, section foreman, Minneapolis & St. Louis; Robert White, section foreman, Grand Trunk Western; John Bednarz, section foreman, Great Northern; and N. P. De Nardo, section foreman, Alton. Mr. Herrington advocated loading the ties lengthwise of the track, believing it to be less hazardous, particularly if some of the ties should fall off. The others were of the opinion that it is safer to do the loading in layers alternately crosswise and lengthwise.]

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Length of Adzes

The A.R.E.A. specifications for adzes admit three lengths, measured under the eye, of 7, 8 and 9 in., weighing 5, $5\frac{1}{4}$ and $5\frac{1}{2}$ lb., respectively. Which of these tools is most satisfactory? Why ?

No Definite Way to Determine Best Length

By C. W. BREED

Engineer of Standards, Chicago, Burlington & Quincy, Chicago

Since there are so many opposed opinions and contradictory conclusions based on experience with this tool, there does not seem to be any way of determining what is the best length of an adze blade. Where adzing over the rail is necessary, as in regaging track, the height of the rail becomes a factor in determining this length. A very high rail calls for the use of a long blade; low rail for a shorter blade.

The kind of track laborers generally employed might determine the best length of adze blade to select. Mexicans, Japanese, etc., who are generally of short stature, can best use a lighter and shorter adze. Native Americans and Negroes, because of their greater height, can best use a long blade.

Another consideration should be that of the allowable repair limit. Grinding an adze reduces the length of the blade. If the repair limit is fixed at 2 in., then the underhead lengths of the three sizes when worn out become 5 in., 6 in. and 7 in., respectively, so that if the 7-in. length is the minimum for satisfactory service and 2 in. is the repair limit, then the 9-in. blade should be selected.

On the Burlington, the heaviest rail in use is the 110-lb. R.E. section. We have selected the 7-in. blade, but we specify $1\frac{1}{2}$ in. for the repair limit on the principal main lines. When this limit has been reached, the adzes are sent to branch lines where an additional $\frac{3}{4}$ in. of wear is permitted.

Prefers a 4-In. Cutting Edge

By LEM ADAMS

Chief Engineer, Union Pacific, Omaha, Neb.

In our opinion, the A.R.E.A. adze measuring 8 in. under the eye, having a 4-in. cutting edge and weighing $5\frac{1}{4}$ lb., is the best balanced tool of the three different sizes. We prefer the 4-in. cutting edge for the reason that a better and more even job of grinding can be done on a blade of this width, which means that a better job of adzing will result.

Thinks 7-In. Tool Is Safer to Use

By J. J. LaBAT

Assistant Bridge and Building Foreman, Missouri Pacific, Wynne, Ark.

As a result of improved methods in framing timbers for railway bridges, which eliminate most of the heavy adzing that was necessary in former years, a lighter adze than was then used is satisfactory. In house carpentry, the adze is less frequently used than it was when more timbers were hand hewn and framed. It has many uses, however, for rough dressing and shaping preparatory to the application of finishing tools. In general, this preliminary work can be done better with the light adze. The adze is a dangerous tool, even in the hands of experienced and skillful men. Bridge and ship carpenters of long experience sometimes inflict wounds on their feet when using adzes. My experience leads me to prefer a 7-in. adze weighing 5 lb., because this size has demonstrated greater freedom from injuries on the part of the users, while more and better work can be done with it, of the class we now handle.

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Length of Rails on Curves

By what simple method can the total difference in the length of the outer and inner rails of a curve be determined ?

One Inch Per Degree of Central Angle

By THOMAS WALKER

Roadmaster, Louisville & Nashville, Evansville, Ind.

For each degree of central angle in any curve, the inner rail is 1 in. shorter than the outer rail. The exact constant for standard gage is 0.98611 in. which is so close to 1 in. that this is near enough for all practical purposes. If the distance between centers of rail heads is taken instead of standard gage, say 59 in., the constant

for each degree of central angle is 1.03 in., which is so slight a variation from 1 in. that the difference can be ignored, 1 in. being an extremely convenient unit.

Track charts should show the central angle of all curves, in which case the difference can be secured immediately without the necessity of any calculation. This rule holds good for simple and compound curves and for spirals, regardless of the degree, or rate, of curvature. The total central angle is all that needs to be known. If this information is not available in the field, it can be approximated closely by obtaining the length in stations of 100 ft., by counting the rails if a tape is not handy, and multiplying this by the degree of curve. If the curve is fitted with spirals, the length should be measured from the center of the spiral and not from the outer end. If the curve is compounded, each simple curve should be estimated separately and the several sections totalled.

I have found this rule very convenient in laying new rail, to ascertain how many short rails are needed to break joints properly on the low side of the curve. I have also found it especially convenient in laying new rail on certain sharp curves where rail wears rapidly and it is desired later to transpose the inner and outer rails as soon as the wear justifies doing so. In such cases, I have started around the curve with the joints in the low rail spaced one-half the difference off center with the outside rail. By doing this and using full length rails on the curve the joints at the center of the curve are on centers, while at the far end they will be off center the same amount as at first but in the opposite direction. In other words, this permits the short rails to be introduced on the tangents and simplifies the transposition of the rails when it is necessary to interchange them with those from the high side.

Since the adoption of prebored ties, we also find the application of this rule particularly convenient for laying heavier rail on curves. Our ties are prebored to fit the tie plate punching on the line rail. In laying heavier rail, provided the difference in weight is not so great as to make the gage of the track too tight, it is the practice to lay the line rail first, in which event it is necessary to pull the inside spikes only. When a curve is reached, we can continue to lay the line rail, regardless of whether it is on the inside or outside of the curve, since we know just how much shorter the inner rail will be and can introduce the proper number of short rails to secure the desired spacing of the joints.

It was our former practice to regard the inner rail as the line rail, but the present rule is that, with few exceptions, as on double track where the outside rail is the line rail, the east rail is the line rail, regardless of curves. This rule was adopted so that the line rail would be continuous, to facilitate the laying of heavier rail on single track.

Central Angle Must Be Known

By ARMSTRONG CHINN

Chief Engineer, Alton, Chicago

To determine the excess length of the outer rail of a curve, only two things need to be known—the gage of the track and the central angle of the curve. If a standard-gage curve were extended to become a complete circle, regardless of its radius, the outer rail would always be 29.58 ft. longer than the inner rail, when measured along the gage side of the head. This difference is the product of twice the gage times Pi, or 3.1416.

To determine this excess for any particular curve laid to standard gage, first ascertain the total central angle. Then determine what per cent this is of a complete circle, that is, of 360 deg. Then multiply 29.58 ft. by this percentage and the result is the difference sought, in feet. For example, suppose the central angle is 36 deg., which is 10 per cent of 360 deg. Ten per cent of 29.58 is 2.958 ft., which is the excess length of the outer rail for that curve.

This is useful information for anyone in charge of laying rail, since it permits him to determine in advance how many short rails to provide for the low side of each curve so that the joints will be spaced properly at the ends of the curve.

Two Problems Are Involved

By CLARK M. STANWOOD

Section Laborer, Chicago & North Western, Morse Bluff, Neb.

The length of any arc is found by multiplying the radius by 3.1416 and this product by the number of degrees subtended by the arc, and dividing the final product by 180. If the length of the inner and outer rails is determined in this manner and the difference is taken, it will be found to be 1.03125 in. for each degree of central angle. From this the following simple rule is deduced:

For light curves laid to standard gage multiply the length of the curve in feet and divide by 100 to get the number of stations. Multiply this quotient by the degree of curve to get the number of degrees of central angle. Then by multiplying the number of degrees of central angle by 1.03125, the difference in length of the inner and outer rails will be obtained in inches. This factor is constant for curves laid to standard gage.

For sharp curves that are laid with widened gage, however, another solution is necessary. The simplest rule is to measure the distance between the middle of the heads of the inner and outer rails, then multiply this distance in feet by the length of the curve in feet and divide this product by the radius of the center line of the track, or the radius of the track curve. The quotient will be the difference in length expressed in feet. If a table of curve radii is not available, the radius can be obtained by the following formula:

$$R = \frac{c^2}{8m} + \frac{m}{2}$$

where R = the radius; c = the chord; and m = the middle ordinate. The measurement of the chord and middle ordinate can be taken on the gage side of the outer rail. From the value of the radius as thus obtained, it is necessary to subtract half the widened gage to obtain the radius for the middle of the track.

[Correct answers to this question were also received from Walter R. Roof, bridge engineer, Chicago Great Western; John W. Riggans, supervisor, Baltimore & Ohio; Charles E. Sandoval, section foreman, Southern Pacific; H. E. Herrington, section foreman, Minneapolis & St. Louis; L. D. Gardner, extra gang foreman, St. Louis- San Francisco; and W. E. Tillett, assistant foreman, Chesapeake & Ohio. Messrs. Riggans and Sandoval included in their replies the same rule that was given by Mr. Stanwood for sharp curves with widened gage. Several of the others deduced the formula to show how the first rule was derived.

The length of any circular arc can be obtained by the formula $L = \frac{2\pi \triangle R}{360} = \frac{\pi \triangle R}{180}$, in which L = the length of the arc; $\triangle$ = the number of degrees of central angle; π = 3.1416 and R = the radius. If we let R and r represent the radii of the gage lines of the outer

and inner rails, respectively, L and l the respective lengths of these rails and g the gage, and remembering that R-r = g, then $L\text{-}l = \frac{\pi\triangle(R\text{-}r)}{180} = \frac{\pi\triangle g}{180}$.

If g is taken in inches, the formula becomes $L\text{-}l = 0.98611\triangle$, or if taken in feet, $0.0822\triangle$.—Editor.]

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Enginehouse Drains

What means can be employed to prevent the clogging of enginehouse drains by cinders, wastes, boiler scale, etc., washed from the floor and pits ?

It Is Difficult to Prevent Clogging

By M. H. DOUGHTY

Division Engineer, Delaware, Lackawanna & Western, Hoboken, N. J.

It is difficult to prevent the clogging of enginehouse drains by cinders, waste, boiler scale, etc., washed from the floor and pits. It is desirable, therefore, that these drains be constructed in such a manner as to be readily accessible for cleaning. We believe it is in line with good practice to have the floor of the pits on a slight grade, say 3 in. in the total length of the pit, with small gutters on one or both sides. They should drain into a sewer extending around the enginehouse immediately at the inner end of the pits. The floor line of the sewer should be somewhat below the level of the pit floor. Where the sewer extends between the adjacent pits, it should be of good size, preferably an arch or a concrete box of not less than 2 ft. square.

To avoid possibility of injury to employees, it is believed to be good practice to floor the end of the pit over the sewer. It is doubtful whether there is any advantage in placing bars or gratings to prevent debris entering the sewer. The reason for this is that employees working on locomotives are often under considerable pressure to get them out on time; and they are quite likely to remove the gratings to clear the pit, even though they may have been so installed as to be difficult of removal.

All sewers and other drains around enginehouses should be made ample in size, preferably not smaller than a 12-in. pipe, either tile of concrete pipe being satisfactory. It is believed that there is no special advantage in oval pipe or in grades that are steeper than is required for ordinary drainage, it being understood, however, that reasonably steep grades are desirable for all drains. It is desirable that good sized openings or manholes be provided at every change in direction of the drain and at every change in grade.

Owing to the practical impossibility of keeping waste and rubbish out of enginehouse drains, it is necessary that they be cleaned regularly and systematically, preferably not less than three or four times a year, particularly where any considerable number of engines are handled. An important factor in avoiding clogged drains is to make them adequate in size and readily accessible for cleaning.

Sewers Should Be Large and Accessible

By A. L. SPARKS

Architect, Missouri-Kansas-Texas, St. Louis, Mo.

Cotton waste used by wipers and hostlers is probably the chief factor in the clogging of drains in enginehouses. Small ravelings are dropped here and there unnoticed, and later become attached to rough places in gutters and drains to form a nucleus for an accumulation to which all manner of foreign substances easily cling.

Small sewers and floor-drain inlets should be avoided. Floors should be sloped to drain over the rails and directly into engine pits. Sewers from pit to pit should be large and sufficiently open so that they can be rodded out easily with a pole, in case of stoppage. Each pit should be provided with a suitable grating of wood or metal at the sewer inlet, which will serve as a strainer to intercept foreign substances. They should be inspected and cleaned daily.

Immediately outside of the building, beyond the last pit, a brick or concrete catch basin should be provided to intercept all drainage before it enters the yard sewer. This basin should be of sufficient size to contain all of the heavier particles washed out through the drains and it should be constructed with manhole covers of ample size to provide room for frequent cleaning.

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Thawing Underground Pipes

What methods can be employed to thaw underground pipe lines that are frozen? What precautions should be observed ?

Prefers to Use Electricity

By J. R. HICKOX

Hydraulic Engineer, Chicago, Burlington & Quincy, Chicago

Every winter brings its epidemic of frozen pipe and fittings. Usually the first severe weather finds a number of such places, particularly where changes have been made and the pipes are not sufficiently protected, or where annual protection is required. Another kind often occurs at the end of long, severe winters, or early in the spring following such winters. Many believe that the sun shining on the ground drives the frost down. The real reason, however, is that the layer of frozen earth continues to absorb heat from the warmer ground below, causing the frost line to travel downward until the heat from above overtakes the frost line below. For this reason, pipes that are well below ordinary frost may freeze suddenly at the end of a long cold winter, sometimes after the warm weather is far enough advanced to have thawed three or four feet below the surface.

Troubles of the first class are usually quite easily located, are confined to limited areas, and are accessible to be reached easily with a blow torch. The others are not so easily located or reached, and before they can be thawed, they often extend over a considerable length of pipe.

In cities, where there is enough thawing to warrant the expense, the best method is to have a large transformer for stepping the high voltage down to about five volts with a corresponding increase in amperes, mounted on a truck, so that it can be taken to the scene of the trouble. The high side is connected to a lighting or power circuit and the low voltage side must be connected so that, to complete the circuit, the current must pass through the pipe. When the current is turned on, sufficient heat is generated to start the water flowing and the running water soon completes the job.

For most railway pipe lines, however, these facilities are not available, but steam can usually be obtained from a locomotive or other source. By opening the frozen pipe and inserting a small pipe carrying steam, heat can

be directed to the point of trouble and the pipe soon thawed out.

Like other forms of trouble, every case is somewhat different from others. Often, a little ingenuity will save much time and expense. In all cases, after a pipe has once frozen, steps should be taken to insulate or otherwise protect it so that it will not freeze again.

Several Methods Can Be Employed

By J. A. RUSSELL,
Manager of Water Service, Pennsylvania, Philadelphia, Pa.

Frozen pipes may be thawed by either of the following methods, selecting the one that is most practical for the particular case: (1) By excavating a trench along the pipe line and building a fire over the pipe; (2) by uncovering the pipe and using torches; (3) by uncovering the pipe and using steam jets; (4) by cutting the pipe, inserting a small pipe and introducing steam; or (5) by the use of electricity. There are also some cases on record where the heat generated by slaking lime has been utilized to accomplish the thawing. Under this scheme, a trench was made, the lime was placed over the pipe and the necessary water added.

Another case of record is that of a water company which uses a portable low-pressure steam boiler and a small auger device which has passages through it. With this device, a hole is bored through the ground to reach the pipe. Steam is introduced through the passages as the boring proceeds, thus thawing both the ground and the pipe line.

Generally speaking, however, I believe that the electric method is the cheapest and most desirable. In using any method, however, precaution should be taken to disconnect the frozen pipe line from any house or building systems. In addition, proper openings should be maintained in the frozen line at all times so that it can clear itself of ice. If electricity is used, the job should be turned over to the power company, unless the railway representative has had experience in this method. It is extremely important to use proper voltage, amperage, fuses, etc. If the pipe line in question freezes again, steps should be taken to lower or otherwise protect it.

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Rise of Switch Points

What causes switch points to rise? What can be done to correct this trouble **?**

Numerous Causes, But Simple Remedies

By H. F. FIFIELD
Engineer Maintenance of Way, Boston & Maine, Boston, Mass.

Switch points rise from the following causes: (1) Poor ties under the heel of the point; (2) heels of the point low in surface; (3) too much expansion at the heel of the points, particularly in the case of short switch points; (4) points installed with plates in which the risers are not properly graduated to keep the points in the proper plane with respect to the stock rail; (5) plates bending under the heel of the points.

To correct conditions (1) and (5), only sound ties should be permitted to remain under the heel of the points and adjacent thereto, while plates of sufficient thickness to prevent bending should be used. To correct condition (2) the heel of the points should be kept tamped solidly, and sound hardwood ties used, which are properly spiked at the heel. Care should be exercised to insure that the heel of the point has good joint fastenings, with the bolts tightened properly to allow movement of the point horizontally a sufficient amount to open and close without binding.

To correct (3) the expansion should be closed up at the heel of the point. The remedy for condition (4) is to put in properly graduated plates and to see that the heel blocks fit properly to prevent the points from rising.

Low Heels Most Common Cause

By L. J. DRUMELLER
Division Engineer, Chesapeake & Ohio, Hinton, W. Va.

Probably the most common cause for the rising of switch points is that the heel of the point is allowed to get low. It has been my observation that where this condition occurs, it will be found that there is a tendency on the part of the foreman to allow the track bolts at the heel of the switch to become slightly loose, which facilitates the throwing of the switch. Obviously, the remedy for this is to tighten the bolts to make the joint more rigid, yet, so far as practicable, it should be flexible enough for the points to work freely.

Another solution is to adopt the "floating" heel, which allows the bolts to be well tightened. Low headblock ties will also cause this trouble, the remedy being to tamp these ties to a uniform surface. I have observed in many instances that it is a common practice to place a metal strap across the headblock ties with a view to minimizing this trouble, as it will hold the switch rods down and thus prevent the points from rising.

Three Principal Causes Are Responsible

By J. F. PETERMAN
Yard Foreman, Minneapolis, St. Paul & Sault Ste. Marie, Superior, Wis.

There are three principal causes for rising switch points. The first, and probably the most common, is low spots either ahead of the switch points or back of the heel. Second, canted riser or slide plates will almost invariably cause this trouble, while bent angle bars at the heel of the points are a third cause.

Probably the simplest way to eliminate the first of these causes is to insist that the joint in the stock rail shall be not less than 10 ft. ahead of the points. By using either a 33-ft. or a 39-ft. stock rail, this is easily done with 15-ft., 18-ft. and 20-ft. points. Where this is done, little trouble is experienced in keeping proper surface. To remove the second cause, which usually develops during the winter, the plates should be removed and the ties adzed to give an even, level bearing. The remedy for the third condition is to replace the bent angle bars with new bars and keep the bolts tight. The ties should be sound and properly spaced. No matter how slight a bend there is in the angle bars, it will cause the points to rise.

This Condition Is Far Too Common

By W. H. SPARKS
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

This question touches on a subject that should be constantly in the mind of alert maintenance officers, while the conditions which cause the trouble should be searched for carefully at every switch inspection. Only a few years ago, when 7 or 8 relatively thin slide plates constituted a set, this was probably the most troublesome

condition with which the section forces had to contend. Today, with our heavier rail and heavy plates that extend beyond the heel of the point, conditions are less aggravated but the trouble is far more common than it should be.

One of the most important, as well as the most frequent, causes of rising points is the failure to keep the joints ahead of the switch and at the heel of the points tamped to proper surface. Joints should be not less than 6 ft., and preferably 10 ft., ahead of the points. Otherwise it is next to impossible to hold the track to surface at and immediately ahead of the points. A low joint at the heel or a low spot at the points will invariably cause the points to rise under passing trains, particularly if any or all of the ties throughout the length of the points are solid and tamped to surface.

This brings up the desirability of having a standard diagram showing standard rail lengths and joint locations for turnouts. Without such a standard, a rail gang, in the hurry to get through switches, is quite likely to install turnouts with little thought as to the effect on maintenance. With switch points varying from 16½ to 33 ft., it is not always easy to arrange for the proper location of the joints unless the turnout rails have been cut and drilled in advance.

Another factor, less common but probably the most dangerous of all, is the neglect to replace stock rails when they have worn to the limit of safety. When a stock rail is allowed to wear down, the point becomes high or wears correspondingly. Then, if a new stock rail is installed without changing the worn point, a real hazard is involved.

All ties through a turnout should be sound and tamped to an even surface. This is especially important at the heel of the point, throughout the length of the switch rail and beyond the joints ahead of the points. Deteriorated ties at the heel of the points eventually cause a low joint, even with the heaviest plates, and probably bent angle bars, with the result that the points rise as the wheels strike the low spots.

When a switch is run through, the head and bridle rods and cuffs are almost always bent. In this event, one or both points may be expected to rise. The remedy is to replace the bent parts and, if this can be done, straighten them outside of the track. A bent cuff should never be allowed to remain in service, since it will be almost certain to cause the points to rise.

Keep the Slide Plates in One Plane

By N. P. DeNARDO

Section Foreman, Alton, Ocoya, Ill.

Switch points often rise because the heel of the points is allowed to become low, causing the points to teeter. To correct this, the heel plate should be raised, adzing the tie if necessary to provide an even bearing. In some cases, the trouble is caused by high ties somewhere along the length of the points. In this case the high tie or ties should be adzed unless it is desirable to raise the remaining ties to this elevation. In any event, rising switch points can be avoided by keeping all of the slide plates in the same plane and the ties ahead of the points and back of the heel tamped solidly.

[Similar answers were received from W. R. Garrett, yard foreman, Chicago, Burlington & Quincy; H. E. Herrington, section foreman, Minneapolis & St. Louis; John Bednarz, section foreman, Great Northern; and W. E. Tillett, assistant foreman, Chesapeake & Ohio, Maysville, Ky. Mr. Garrett called attention to the practice in yards of digging too deep when providing for drainage of the points, which results in surface-bent points when thawing occurs first at this place. Mr. Tillett also called attention to the importance of perfect cross level, as well as of good surface, and the essential requirement that the slide plates must all be in one plane. —Editor.]

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Winter Bridge Inspections

What items should be given particular attention during winter bridge inspections, in addition to those to be noted during summer inspections ?

Observe Action of Snow, Ice and Frost

By General Bridge Inspector

Since bridge inspections are made primarily to insure the continued safety of these structures, every defect or condition which might impair this safety should be discovered and examined closely. Secondary, but by no means unimportant, reasons are to determine what maintenance is required to avoid deterioration and whether smooth riding conditions are being maintained, together with what corrections may be necessary in the event that defects exist. For these reasons, every item of summer inspection, except possibly that of fire hazard around trestles, should be included in the winter inspection.

In addition, snow and ice conditions and drainage on bridge seats and bridge decks should be noted and marked for such correction as may be necessary. The ice conditions in streams should be investigated together with the adequacy of the channel for some distance above and below the structure. A special search should be made for evidence of frost action in masonry, particularly in old stone piers and abutments and in masonry culverts.

Not infrequently, heaving affects individual piles and sometimes entire bents in pile trestles. This is a matter that should not be overlooked, and special attention should be given to it in structures that have previously given trouble of this kind. Heaving sometimes tends to displace wing walls and back walls. Observation should also be made to determine whether such action is affecting these parts of the substructure. In a word, all of the items that should be observed in a summer inspection should be included in a winter inspection and, in addition, all possible factors of deterioration or of hazard which may result from snow or ice and the freezing of the earth.

Winter Adds to the Factors to Be Observed

By Bridge Engineer

Winter conditions do not eliminate any of the hazards or forms of deterioration to which bridges are subjected during the summer, except that the process of decay in wooden members is suspended in cold climates. Extremely cold or stormy weather does, however, add to the items which must be given attention when making inspections during the winter months.

Frost is one of the greatest enemies of masonry, while it may cause troublesome heaving back of walls and in pile bents. Snow and ice on bridge seats and even on the decks may create conditions which require attention. Ice in streams sometimes threatens the safety of structures. For these reasons, a relatively large number of items relating to drainage, snow, ice, freezing and

thawing should be observed closely during winter bridge inspections. The history of the various streams crossing the line should be studied and observation made of the ice conditions for some distance above the bridges and of the size, alinement and possible obstructions in the channels both above and below the structures, particularly with respect to streams that have previously caused ice trouble.

Heaving of piles is sometimes one of the most difficult things to catch on an inspection. A single pile or one or more whole bents may heave. It is seldom that this condition can be foreseen, although some trestles give trouble on this account every year. Others may never do so, while still others which have not done so for several years may start heaving unexpectedly. Sometimes heaving occurs slowly; at other times it may be quite rapid. Not infrequently, there may be no evidence of it at the time the inspection is made, although a few days later it may become aggravated. In any event, this is an item that should be scrutinized closely at the time the inspection is made.

Search should be made for evidence of frost action in piers, abutments, headwalls, culverts, retaining walls and other masonry structures, particularly those containing stone masonry. These observations should include the possible tipping or displacement of wing walls, back walls and headwalls, as a result of the freezing of the earth behind them.

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Lubricating Turntables

What type of lubricant is most satisfactory for turntable centers during the winter? For end trucks ?

Proper Lubrication Reduces Maintenance

By FRANK R. JUDD

Engineer of Buildings, Illinois Central, Chicago

I consider this question too important to be answered in general terms, particularly because the varied conditions in different sections of the country have a bearing on the type of lubricant that should be used.

On the Illinois Central we lay much stress on proper and adequate lubrication. We issue detailed instructions to turntable operators, in the form of a circular, in which the question of lubrication is called to their attention and emphasized. Among the requirements which they must fulfill are that all oil cups must be kept filled and working properly; oil holes must be well supplied with oil and protected with waste or dust caps; grease cups must be kept full and the cap given one turn every day; and oil cellers must be supplied with clean wool waste which is well oiled. Obviously, the foregoing instructions apply to bearings, other than the center bearings, hinges and gears, but they are cited to show the importance we place on constant, systematic lubrication. Where there are roller bearings, this being particularly on our three-point turntables, we use a grease and require that the intervals between applications shall be not more than two weeks.

At present we are using car oil for lubricating our center bearings, requiring the application of a minimum of 1 gal. every two weeks. No other form of lubrication is permitted, but we require the use of summer and winter oil, according to the season. We also require that centers be drained and cleaned at least twice a year, and the date recorded. In addition, the center must be drained and new oil applied if water in the pit submerges the center. Equally detailed instructions are given for the lubrication of the electric and air motors which drive the operating mechanism.

While we specify that oil shall be used for lubricating the center bearing, we have been experimenting during the last year with a grease, which we hope will stand up under this service and render satisfactory results in extreme cold weather, although we have not as yet reached a conclusion in this matter. The grease we have selected tentatively is of such a consistency that it does not channel, yet provides lubrication between the rollers and the upper and lower roller paths. We believe that it is desirable to use grease, especially in centers where there is danger of water rising in the pits and floating off the oil. Our experience demonstrates that if the center machinery and end trucks are properly lubricated, the maintenance of the turntable will be reduced to a minimum.

Light Grade of Grease Preferred

By H. S. LOEFFLER

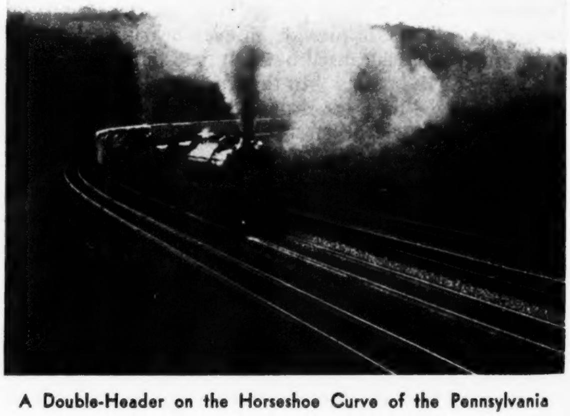
Bridge Engineer, Great Northern, St. Paul, Minn.

Our experience indicates that a light grade of grease is best for lubricating roller-type center bearings for turntables. The roller compartment should be completely filled with the lubricant, and additional grease should be forced into the roller compartment with a grease pump at intervals of one to six months, as may be required.

When oil is used for lubricating these bearings, we find that water, dirt and cinders enter the roller compartment through the joint between the top and bottom castings. The water, being heavier than the oil, displaces the latter and causes pitting and corrosion of the rollers and tread plates. Dirt and cinders cause rapid wear, while they interfere with the proper functioning of the bearings. Again, the water will freeze during cold weather. To prevent freezing, turntables operators frequently place live steam pipes around the center bearing or add wood alcohol to the lubricant. Obviously, such methods are not desirable.

If the roller compartment is filled with grease, so that a small amount discharges through the opening between the top and bottom castings, it will be impossible for either water, dirt or cinders to enter the roller compartment. We have used this form of lubricant for this purpose for the past three years.

Turntable center bearings of the disc type generally have to be lubricated with oil. I see no reason, however, why they could not be designed for grease lubrication. I believe that the grease lubricant would be satisfactory if applied at frequent intervals.



A Double-Header on the Horseshoe Curve of the Pennsylvania

News of the Month . . .

N. R. A. A. Not to Hold Annual Exhibit

The National Railway Appliances Association has decided not to hold its annual exhibit at the Coliseum, Chicago, during the convention of the American Railway Engineering Association in March because the convention has been curtailed to two days, affording no time for the inspection of the exhibits. Arrangements are being made to maintain a skeleton organization of the Appliances Association looking to an exhibit in 1934.

Number of Workers in Transport Equipment Industry Declines

The number of establishments engaged in the manufacture of air, land and water transportation equipment in the United States declined from 2,550 in 1929 to 2,037 in 1931, according to a preliminary report by the Bureau of the Census of the Biennial Census of Manufacturers in 1932. The yearly average of the number of wage earners employed in such establishments declined from 583,355 in 1929 to 375,003 in 1931 and their total wages from $943,221,905 to $468,574,953. The report also shows a decline in the number of railroad repair shops from 2,297 in 1929 to 2,156 in 1931.

Freight Traffic in November

Freight transported by the Class I railroads in November amounted to 21,754,312,000 net ton-miles, a reduction of 3,329,995,000 net ton-miles, or 13.3 per cent, as compared with the corresponding month of 1931, and 32.7 per cent under November, 1930, according to reports compiled by the Bureau of Railway Economics. For the first eleven months of 1932 these railroads handled 237,894,992,000 net ton-miles of freight, which was a reduction of 75,590,992,000 net ton-miles, or 25.1 per cent, under the corresponding period in 1931, and a reduction of 39.5 per cent under the same period in 1930.

Northern Pacific to Insert A Million Ties

The Northern Pacific plans to place approximately 1,000,000 ties in its tracks during 1933. Preparatory to this program, the company's tie-treating plant at Paradise, Mont., which was closed early last summer, has resumed operations for the treatment of 100,000 crossties and 350,000 ft. b.m. of switch ties, which will be used in the territory between Billings, Mont., and Yakima, Wash. At Seattle, 175,000 ties will be treated under contract for use on the west end of the road, while the company's tie-treating plant at Brainerd, Minn., will resume operations about March 1, for the treatment of about 200,000 ties. The company has in storage about 500,000 ties that were treated in 1932.

Estimate Carloadings Will be Four Per Cent Less in First Quarter

Freight car loadings in the first quarter of 1933 will be four per cent less than the actual loadings in the same quarter of 1932, according to estimates compiled by the 13 shippers advisory boards. Shippers located in the Great Lakes, Ohio Valley and Southwest regions expect increases in carloadings for the first quarter of 4.8 per cent, 6.1 per cent and 1.5 per cent, respectively, while decreases are expected to take place in the carloadings of the other 10 regions. Of the 29 principal commodities, it is expected that the five will show increases in the number of cars loaded.

New Equipment Installed

In the first 11 months of 1932, the Class I railroads of the country placed in service 2,951 new freight cars, as compared with 12,328 cars in the corresponding period of 1931, according to the Car Service Division of the American Railway Association. Locomotives placed in service in the first 11 months of last year totaled 37 as compared with 123 in the same period of 1931. On December 1, 1932, these railroads had 2,398 new freight cars on order as compared with 4,252 on the same date in 1932, while new locomotives on order numbered 3 as compared with 10.

Asks Merger of Canadian Systems

Citing figures to show that Canada has only 236 people per mile of railroad, or less than any other civilized country, E. W. Beatty, president of the Canadian Pacific, made a plea for amalgamation of the Canadian Pacific and the Canadian National, in an address recently before the Canadian Club at Toronto, Ont. "Canada," continued Mr. Beatty, "has several thousand miles paralleled by other miles, serving the same territory and reaching the same terminals. This constitutes our greatest individual item of waste." He deplored the competition of the state, in the form of the Canadian National, with a private company, and added that, because of the development of other means of transportation, a railroad monopoly in the true sense of the word is impossible.

Roads Borrow Extensively in 1932

Throughout 1932 the railroads of this country continued to borrow large sums of money from various sources, according to the records of the Interstate Commerce Commission. Up to the end of the year the commission had approved loans from the Reconstruction Finance Corporation amounting to $359,394,439, on applications aggregating $475,109,649, although not all of the loans comprising this total had been authorized by the corporation. Loans to railroads from the Railroad Credit Corporation totaled $46,931,732, while the railroads borrowed $357,428,001 from other sources on notes. During the year the commission authorized security issues amounting to $1,188,000,739, as compared with $804,403,873 in 1931, but this included a large volume of bonds used for collateral purposes.

Farrell New I. C. C. Chairman

P. J. Farrell, a member of the Interstate Commerce Commission, has been elected chairman of the commission for the ensuing year, succeeding Claude R. Porter, pursuant to the commission's policy of rotating the chairmanship among its members. Former Commissioner E. I. Lewis, whose reappointment for another term was not confirmed by the Senate, has been appointed director of valuation of the commission to fill a vacancy caused by the death of C. F. Staples.

Net for Eleven Months Equals 1.2 Per Cent

For the first eleven months of 1932, the Class I railroads of the United States had a net railway operating income of $301,156,515, which was at the annual rate of return of 1.20 per cent on their property investment, as compared with a net railway operating income of $510,327,096, or 2.03 per cent, in the first eleven months of 1931, according to reports compiled by the Bureau of Railway Economics. Operating revenues for the eleven months totaled $2,915,866,458, as compared with $3,947,775,573 for the same period in 1931, a decrease of 26.1 per cent. Operating expenses amounted to $2,241,180,585 as compared with $3,024,088,636, a decrease of 25.9 per cent. For November, the net railway operating income of these roads was $34,179,119, while for the corresponding months of 1931 it was $36,787,707.

Gov. Pinchot Advocates Maximum Weight for Trucks

The fixing of definite maximum weights of motor-trucks using the public highways in order to conserve public funds and to curb unfair competition with the railroads was advocated recently in a letter which Gifford Pinchot, governor of Pennsylvania, addressed to the governors of the various states. After first discussing the plans of his state for reducing the weight of such trucks, Governor Pinchot gave his reasons for advocating such action in which, among other things, he said: "To build highways at public expense for competition against the railroads is not fair to corporations which bought, graded, built and now maintain their own rights-of-way, and have long supported public enterprise through taxes. Neither is it fair to investors in railroad securities. The decline of railroad earnings in recent years indicates that highway competition has been serious."

Association News

International Railway Maintenance Club

The first meeting of the International Railway Maintenance Club in 1933, will be held at the Hotel Statler, Buffalo, N. Y., on February 9. Following luncheon, which will be served at 12:30 p. m., the club will be addressed by J. J. Brinkworth, assistant superintendent of the New York Central at Buffalo, who will speak on the subject of the relation of the transportation department to the branches of the maintenance department having to do with tracks, bridges and signals.

Maintenance of Way Club of Chicago

About 50 members and guests were present at the monthly dinner of the club on Wednesday evening, January 18, when L. S. Marsh, manager of inspection and metallurgy of the Inland Steel Company presented a talk on the manufacture of rails and track fastenings, which was illustrated by lantern slides and moving pictures. Following the conclusion of his remarks, Mr. Marsh was called on to answer many questions having to do with the manufacture of rails.

Metropolitan Track Supervisors' Club

The next meeting of the Metropolitan Track Supervisors' Club will be held on Tuesday, February 21, at Keen's Chop House, 72 West Thirty-Sixth street, New York. In a change from the usual time of meeting, the business session will begin at 3 p. m., and will be followed by dinner at 5:30 or 6 p. m. The subject of the meeting will be "The Use of Gas and Electric Arc Welding in Track Maintenance," which will be discussed by representatives of the Oxweld Railroad Service Company and the Hallen Welding Company.

Railway Tie Association

President Watkins has appointed a committee to study and report on "Standardizing Lengths and Utilizing Ties in the Grade Proportions Normal to the Woods Run Production." A. R. Fathman, vice-president of the Hobbs-Western Company, St. Louis, Mo., has been appointed chairman of this committee.

The association has completed arrangements with the Railway Age for the compilation of statistics from member companies on tie stocks on hand and blanks have been sent to the members requesting the necessary information. The figures received from individual companies will be assembled for each of the major tie producing areas and will be made public only in totals for those areas. These figures, which it is hoped to extend later to include similar data regarding stocks on railway yards, will give both producers and purchasers knowledge of the relative surplus or shortage of stocks on hand.

American Railway Engineering Association

Reports of all of the committees are now completed and in type. Bulletins 353 and 354, containing the remainder of the reports, will be mailed early in February. The report of the Special Committee on Stresses in Track will be an outline of what has been accomplished during the year. The Sixth progress report of this committee, which is too voluminous to be studied in detail before the March convention, will be published in one of the summer bulletins. The total volume of the reports that are to appear prior to the convention will be about 30 per cent greater than last year.

Bulletin 353 will contain the committee assignments and personnel. The list of committees for 1933 contains a new one, a Special Committee on Economics of Bridges and Trestles, the personnel of which has not yet been chosen. The list shows six changes in chairmen as follows: Roadway, G. S. Fanning, chief engineer, Erie, Cleveland, Ohio, who succeeds C. W. Baldridge, assistant engineer A. T. & S. F., Chicago; Track, C. J. Geyer, assistant to vice-president, C. & O., Richmond, Va., who succeeds C. R. Harding, assistant to president, S. P., San Francisco, Cal.; Buildings, G. A. Rodman, general supervisor bridges and buildings, N. Y. N. H. & H., New Haven, Conn., who succeeds A. L. Sparks, architect, Missouri-Kansas-Texas, St. Louis, Mo.; Yards and Terminals, M. J. J. Harrison, general scale inspector, Penna., Chicago, who succeeds H. L. Ripley, construction engineer, N. Y. N. H. & H., New Haven, Conn.; Shops and Locomotive Terminals, J. M. Metcalf, assistant chief engineer, Missouri-Kansas-Texas, St. Louis, Mo., who succeed L. P. Kimball, engineer of buildings, B. & O., Baltimore, Md.; Rivers & Harbors, W. C. Swartout, assistant engineer, M. P., St. Louis, Mo., who succeeds the late E. A. Hadley, chief engineer, M. P., St. Louis.

Three committees held meetings in January; Yards and Terminals, at Cleveland, Ohio, on January 9; Maintenance of Way Work Equipment, at Chicago, on January 22; and Records and Accounts, at Washington, D. C., on January 22.

The Committee on Arrangements has planned a luncheon for members and guests on Wednesday of the convention at which an outstanding railway executive will be the speaker.

Pennsylvania Inaugurates Electric Train Service

Electric passenger train service between New York and Philadelphia, Pa., was inaugurated on January 16, when trains drawn by electric locomotives left each city for the other. Appropriate ceremonies, in which the mayors of both cities participated, marked the departure of trains on the inaugural runs. Initial electric train service consists of four daily round trips, but this will be increased gradually until the entire schedule of trains between these two cities is electrically operated. It has also been announced that through trains between New York and Washington, D. C., will soon begin running under electric power as far south as Wilmington, Del.

Personal Mention

Engineering

H. F. Brown, assistant district engineer on the Northern Pacific, has been promoted to district engineer, with headquarters as before at St. Paul, Minn., to succeed **Frederick J. Taylor,** retired.

W. C. Groth, division engineer of the Minnesota division of the Chicago Great Western, with headquarters at St. Paul, Minn., has been promoted to chief engineer, with headquarters at Chicago, to succeed **C. G. Delo,** who has been appointed real estate and tax agent with headquarters at the same point. **F. U. Mayhew,** track supervisor, with headquarters at Oelwein, Iowa, has been promoted to division engineer of the Illinois-Iowa division, with the same headquarters, to replace **T. W. Fatherson,** who has been transferred to the Minnesota division at St. Paul, to succeed Mr. Groth.

W. C. Groth

Mr. Groth has been connected with the Chicago Great Western for 27 years. He was born on September 14, 1882, at Preston, Minn., and was educated in civil engineering at the University of Minnesota. Prior to entering the service of the Great Western on March 1, 1906, he served for a short time as a rodman on the Chicago, Milwaukee, St. Paul & Pacific and on location and construction on the Minneapolis, St. Paul & Sault Ste. Marie. He first served the Great Western as an instrumentman at St. Paul, and in 1912, he was advanced to engineer maintenance of way of the Western division, with headquarters at Clarion, Iowa. In 1918, he was transferred to the Northern division at St. Paul, where his title was changed to division engineer in 1929.

Lem Adams, engineer maintenance of way of the Union Pacific System, has been appointed chief enginer of the Union Pacific Railroad and the St. Joseph & Grand Island, with headquarters as before at Omaha, Neb. He succeeds **G. J. Adamson,** who has been appointed division engineer of the Kansas City division, with headquarters at Kansas City, Mo.,

relieving **W. C. Perkins,** whose appointment as roadmaster is noted elsewhere in these columns. The position of engineer maintenance of way of the Union Pacific System has been abolished.

Mr. Adams has served in the engineering and maintenance of way departments of the Union Pacific System for more than 23 years. He was born on June 6, 1886, at Buda, Tex., and received the degree of bachelor of science in civil engineering from the Texas A. & M. college. In June, 1909, he entered the service of the Union Pacific System as a rodman on the Oregon Short Line, where he was appointed a draftsman a year later. In June, 1911, he was made an estimator and served in this position and as chief draftsman until March, 1916, when he was promoted to assistant division engineer. In 1917, Mr. Adams was appointed engineering accountant and a year later he became contract engineer. In 1919, he was transferred to the Union Pacific unit of the system with the title of special field engineer in the maintenance of way department, then being advanced to roadway assistant for the system at Omaha in April, 1920. On May 15, 1929, he was advanced to general supervisor maintenance of way of the system at Omaha, and on September 16, 1931, he was appointed to the newly-created position of engineer maintenance of way of the system.

Lem Adams

Track

Robert S. White, supervisor of track on the Louisville & Nashville, with headquarters at Smith's Grove, Ky., has retired after 48 years of service with this company.

J. A. MacKenzie, a roadmaster on the Canadian Pacific, with headquarters at Lindsay, Ont., has been transferred to Ingersoll, Ont., to succeed **W. A. Neely,** who has been transferred.

J. P. Mack, formerly division engineer of the Los Angeles division of the Los Angeles & Salt Lake, has been appointed roadmaster of the First subdivision of the Los Angeles division, with headquarters at Los Angeles, Cal.

William A. Bulmer, a section foreman on the Canadian National, with headquarters at Flatland, N. B., has been appointed acting roadmaster on the Campbellton division, with headquarters at Campbellton, N. B., succeeding **Kent Branch,** who has retired.

W. C. Perkins, division engineer of the Kansas City division of the Union Pacific Railroad, with headquarters at Kansas City, Mo., has been appointed roadmaster on the Oregon Short Line (a unit of the Union Pacific System) with headquarters at Ashton, Idaho, where he succeeds **W. R. Keay.**

C. R. Gates, assistant roadmaster on the Southern, with headquarters at Hattiesburg, Miss., has been promoted to roadmaster on the Atlanta division, with headquarters at Atlanta, Ga., to succeed **A. P. Bradley** deceased. **J. F. Barron,** supervisor of bridges and buildings, with headquarters at Somerset, Ky., has been appointed assistant roadmaster at Hattiesburg to succeed Mr. Gates.

H. T. Anderson, acting roadmaster on the Eastern division of the Chicago & North Western, with headquarters at Fremont, Neb., has been appointed roadmaster at that point, to succeed **J. J. Wise.**

Mr. Anderson was born on December 10, 1890, at Tilden, Neb., and after a public school education he entered railway service on April 1, 1905, as a trackman on the Chicago & North Western. On April 1, 1912, Mr. Anderson was promoted to track foreman at Atkinson, Neb., where he remained until 1917, when he resigned. He returned to the North Western in April, 1921, as an assistant track foreman in the Norfolk (Neb.) yards and in 1926 he was again appointed track foreman, this time at Oakdale, Neb. In November, 1931, Mr. Anderson was transferred to Norfolk where he remained until his recent promotion to roadmaster.

Bridge and Building

T. Crawford, assistant engineer maintenance on the Southern, with headquarters at Chattanooga, Tenn., has been appointed supervisor of bridges and buildings, with headquarters at Somerset, Ky., to succeed **J. F. Barron,** whose appointment as assistant roadmaster is noted elsewhere in these columns.

G. Tornes, assistant engineer maintenance of way of the Chicago, Milwaukee, St. Paul & Pacific, Eastern Lines, has been appointed to the newly-created position of superintendent of bridges and buildings for the system, with headquarters as before at Chicago, and his former position has been abolished.

Obituary

C. J. Chase, cost engineer of the Boston & Maine, died at Concord, N. H., on December 31, 1932, at the age of 49 years.

A. C. MacKenzie, engineer maintenance of way of the Eastern Lines of the Canadian Pacific, with headquarters at Montreal, Que., died suddenly on January 24 at that place.

T. Crosbie, bridge and building master on the Canadian National, with headquarters at Allendale, Ont., died on January 14 at the age of 60 years.

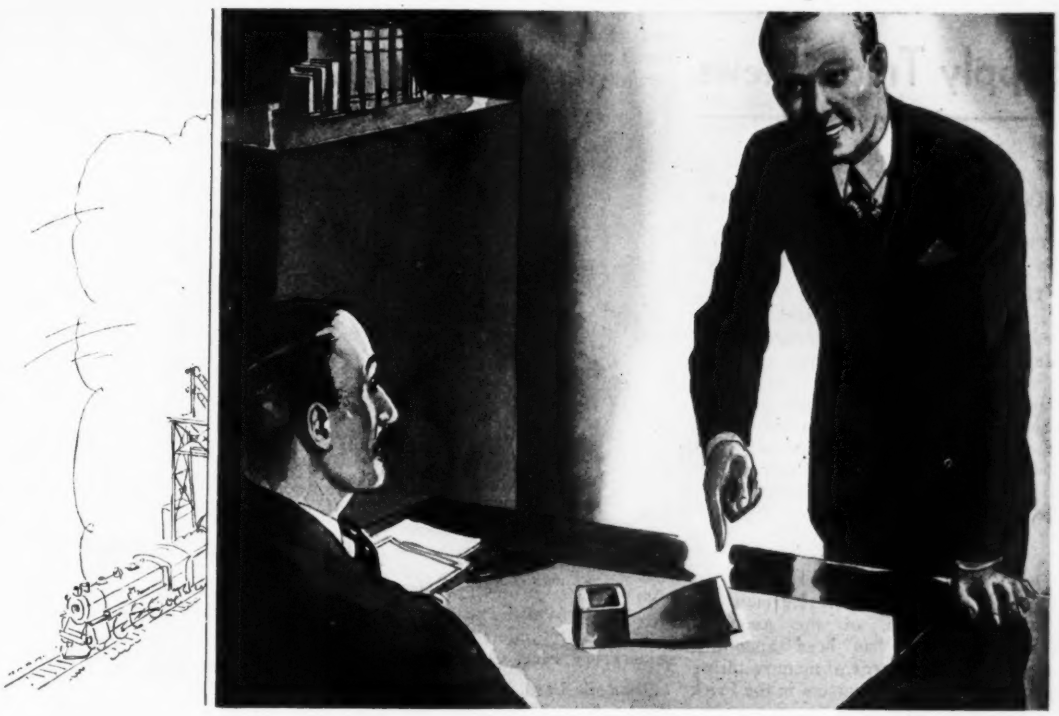
H. M. Hubbard, who retired on December 1, 1925, as supervisor of bridges and buildings on the Illinois Central, with headquarters at Water Valley, Miss., died on November 18, at that place, at the age of 80 years.

Aaron Larson, a track supervisor on the Pere Marquette, with headquarters at Grand Rapids, Mich., died on December 29 at that place at the age of 47 years. Mr. Larson had been connected with this road since August 7, 1903, and had been a track supervisor since October 23, 1920.

Robert I. Rigby, superintendent of buildings on the Central Region of the Canadian National, with headquarters at Toronto, Ont., died in the Wellsley hospital at Toronto on January 15. Mr. Rigby was born on January 4, 1884, in Scotland, and came to Canada 25 years ago where he entered railroad work with the Canadian Northern (now the Canadian National). Mr. Rigby was advanced through various positions and in 1927 he was appointed superintendent of buildings which position he continued to hold until his death.

Milford N. Wells, assistant engineer on the Atchison, Topeka & Santa Fe, with headquarters at Chanute, Kan., and formerly division engineer of the Southern Kansas division with the same headquarters, died at Chanute at the age of 89 years. Mr. Wells was born on August 29, 1843, at Ann Arbor, Michigan, and graduated from the University of Michigan in civil engineering in 1868. After serving with various railroads of this country on location and construction work from 1868 to 1880, he entered the service of the Santa Fe as a resident engineer on construction and served in various capacities in the engineering and maintenance departments until 1907, when he was appointed division engineer of the Southern Kansas division at Chanute. Four years later he was made assistant engineer at the same point, which position he held continuously until his death.

D. H. Howard, engineer of track elevation of the Chicago Rapid Transit Company, who died on December 21 at Lafayette, Ind., as announced in the January issue, was born at Burnettsville, Ind., 55 years ago, and graduated in civil engineering from Purdue University in 1900. He entered railway service the same year on the engineering corps of the Pennsylvania, where he served for two years, after which time he went with the Southern Pacific as chief draftsman, serving successively with this road as office engineer and division engineer. In 1910, Mr. Howard became assistant engineer of track elevation for the Chicago & Western Indiana, and four years later he became engineer maintenance of way of the Chicago, Aurora & Elgin, which position he held until 1918, when he went with the Alton as chief draftsman. A year later he entered the service of the Chicago Rapid Transit Company as engineer of track elevation at Chicago.



Supply Trade News

General

The Williamsport Wire Rope Company, Williamsport, Pa., has been licensed to manufacture preformed wire rope under the American Cable Company's patents.

The American Creosoting Company, Louisville, Ky., has purchased the properties of the **Gulf States Creosoting Company,** including timber treating plants at Hattiesburg, Miss., Jackson and Meridian, Slidell, La., Birmingham, Ala., and Brunswick, Ga. With these six plants, the American Creosoting Company will now control directly and through subsidiary companies a total of 25 timber treating plants.

Personal

George M. Hunter, operating manager, Pittsburgh district, of the **American Bridge Company,** has been appointed vice-president in charge of manufacturing operations, with headquarters in the Frick building, Pittsburgh, Pa.

E. P. Chase, railroad sales representative at the New York district office of Fairbanks, Morse & Co., Chicago, has been appointed manager of railroad sales at this office to succeed **E. P. Vroome,** who has resigned. **R. F. Lane** has been appointed railroad sales representative at New York.

W. S. Shiffer, who has been connected with the **Reading Iron Company,** Reading, Pa., for some time and recently acting as assistant general manager of sales, has been appointed general manager of sales and **J. L. Jacobson,** manager of sales in the central region, has been appointed assistant general manager of sales. Both Mr. Shiffer and Mr. Jacobson will be retained in the general sales office, Philadelphia, Pa. **C. T. Ressler** has been appointed manager of railroad and marine sales and **L. K. Simons,** manager of cut nail sales.

Obituary

Basil Magor, consulting engineer and manufacturer of railroad cars, founder and first president of the Magor Car Corporation, died on January 14 at his home in New York. Mr. Magor was born 62 years ago at Montreal, Quebec, and was educated in the Rensselaer Polytechnic Institute, graduating as a civil engineer in 1894. In 1898 he went to China and was engaged in making plans for building a railroad from Canton to Hankow. In 1902 Mr. Magor founded and became first president of the Magor Car Corporation. For several years up to about five years ago he represented the Magor Corporation in London as its foreign representative and at the time of his death was a director of that corporation, having been succeeded as president by his brother, Robert J. Magor. Basil Magor was also the founder and former president of the National Steel Car Corporation. From 1904 to 1907 he was a partner of the New York consulting engineering firm of Wonham & Magor, and later

Basil Magor

practiced his profession alone. During the World War he was a district manager at Port Jefferson, L. I., for the Emergency Fleet Corporation.

John B. Lord, chairman of the board of the Ayer & Lord Tie Company, Chicago, died in that city on January 21 after an illness of 10 months. He was born at Newton Upper Falls, Mass., on June 3, 1848, and entered his father's grain and flour business in 1867. From 1875 to 1882, he was a general buyer and shipper of grain through central Illinois. In the latter year, he entered the railroad lumber supply business with C. W. Powell at Paris, Ill., and Chicago, which occupation he followed until 1893, when he became president and manager of the Ayer & Lord Tie Company. He held the latter position until 1924, when he was

John B. Lord

elected chairman of the board, the position he held until the time of his death. Among his various enterprises he was particularly active in wood treating, constructing the Carbondale treating plant of the Ayer & Lord Tie Company in 1903. In addition, he was the first man to import creosote in tank steamers. Mr. Lord was also intensely interested in civic matters. He donated a large collection of books to the Newberry Library in Chicago and helped to organize other public institutions. In 1893, he made possible the construction of the wood treating plant exhibited at the World's Fair in Chicago. Later, this plant was moved to Little Rock, Ark., where it is still operated.

Edwin M. Herr, vice-chairman of the board of directors of the Westinghouse Electric & Manufacturing Company, died on December 24 at his home at New York. Mr. Herr was born on May 3, 1860, at Lancaster, Pa., and while still in school he served with the Western Union Telegraph Company as a messenger and operator. Mr. Herr then entered railway service as a telegraph operator on the Kansas Pacific (now part of the Union Pacific), where he later became station agent at Deerfield, Colo. Resuming his education in 1881, Mr. Herr graduated from the Sheffield Scientific School of

Edwin M. Herr

Yale University in 1884. Later he entered the service of the Chicago, Burlington & Quincy, serving successively as mechanical draftsman, engineer of tests, superintendent of telegraph and division superintendent. In 1891 he went with the Chicago, Milwaukee & St. Paul (now the Chicago, Milwaukee, St. Paul & Pacific) as a division master mechanic, leaving this company two years later to go with the Grant Locomotive Works as general superintendent at Chicago. Subsequently Mr. Herr was appointed general manager of the Gibbs Electric Company, Milwaukee, Wis., and in 1895 he was appointed assistant superintendent of motive power of the Chicago & North Western, becoming superintendent of motive power of the Northern Pacific a year later. Mr. Herr was appointed general manager of the Westinghouse Air Brake Company in 1896 remaining with that company until 1905 when he was elected first vice-president of the Westinghouse Electric & Manufacturing Co. In 1911 Mr. Herr was elected president of the company, resigning this position in June, 1929, to become vice-chairman of the board.

Fairmont Light Section Car.—Fairmont Railway Motors, Inc., Fairmont, Minn., has issued a 12-page booklet, known as Bulletin No. 302, in which is described and illustrated this company's M14 one-man section car.

"SPIKE 'EM DOWN!"

WITH only a pair of hands at either end of the heavy rail to guide it into position, it is lifted, swung and eased down by a light pull on a lever handy to the "Caterpillar" Tractor's driver! Then the "Caterpillar" Tractor equipped with Allsteel Sideboom hustles to the next rail and repeats. This combination has laid rails as fast as one a minute! And it unloads, carries and places frogs and switch points and speedily handles the weld-joined rails at the crossings.

Rail traffic keeps on schedule—the "Caterpillar" Tractor gets off the track quickly to let a train pass, and gets back on the job without delay. When the gang reaches a bridge this nimble, responsive tractor walks right over on the ties. On its own broad tracks, the "Caterpillar" Tractor goes most anywhere, any time.

And with this cost-cutting duty completed, the "Caterpillar" Tractor does plenty of other important railroad jobs to keep busy saving money the year round!

Caterpillar Tractor Co., Peoria, Ill., U. S. A.
Track-type Tractors Combines Road Machinery
(There's a "Caterpillar" Dealer Near You)

Prices — f. o. b. Peoria, Illinois

FIFTEEN	$1100	FIFTY	$3675
TWENTY	$1450	DIESEL FIFTY	$4500
TWENTY-FIVE	$1900	SEVENTY	$4750
THIRTY-FIVE	$2400	DIESEL SEVENTY	$6250

CATERPILLAR

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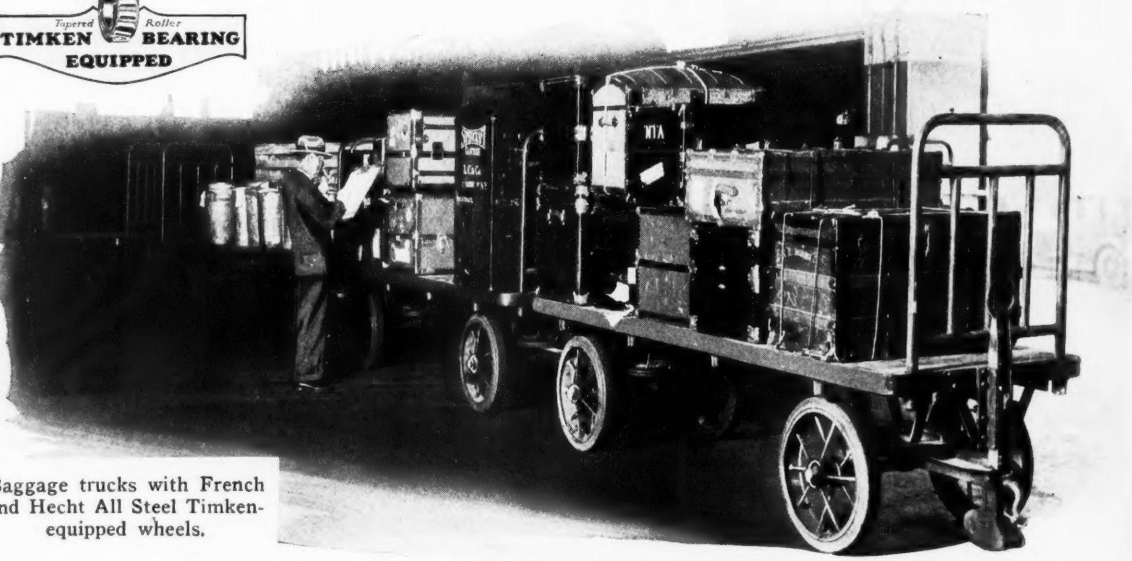
TRACTOR

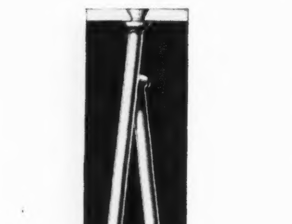
ALPHABETICAL INDEX TO ADVERTISERS

TIMKEN Tapered Roller BEARING EQUIPPED



Baggage trucks with French and Hecht All Steel Timken-equipped wheels.

Place That Baggage Handling Job On Timkens—Save Time, Avoid Congestion



Timken-equipped French and Hecht wheel.

The same exclusive combination of bearing qualities that has taken the grief and excessive cost out of the railroad's toughest jobs—in passenger cars, locomotives and section cars—makes a proportionate saving on the lighter jobs... Timken Tapered construction; Timken positively aligned rolls and Timken-made steel.

That's why the use of Timken Bearings has spread to so many other types of railroad equipment.

No other type of bearing has the versatility in load carrying and the endurance to meet all railroad bearing requirements as Timkens meet them.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

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